EBRUARY 21, 1921 Issued Weekly PRICE 15 CENTS

AVIATION AND AIRCRAFT JOURNAL

Aerial View of Mount Vernon

VOLUME X
Number 8

Four Dollars a Year

SPECIAL FEATURES

THE JACUZZI SEVEN-PASSENGER MONOPLANE
CIVILIAN AVIATION SCHOOLS
VENEER OR METAL CONSTRUCTION ?
AERO ENGINE EFFICIENCIES
SPEED MEASUREMENT OF AIRPLANES

THE GARDNER, MOFFAT CO., INC.
HIGHLAND, N. Y.
225 FOURTH AVENUE, NEW YORK

Entered as Second-Class Matter, Nov. 22, 1920, at the Post Office at Highland, N. Y. under Act of March 3, 1879.

Interior, Foreward Cabin of Aeromarine Navy 11 Passenger Flying Cruiser

Transportation by Aeromarine Navy Flying Cruiser has proven advantages over all other methods of travel.

The opportunities for organizing fleets of these airboats into daily service have scarcely been scratched.

We have helpful data on advisable routes, ports of call, etc., and invite inquiry.

The chance for success in the world's greatest transportation advancement is here and waiting for you.

Aeromarine

AEROMARINE PLANE & MOTOR CO., TIMES BUILDING, NEW YORK
LARGEST EXCLUSIVE BUILDERS OF FLYING BOATS IN AMERICA

FORMER ARMY AND NAVY FLIERS

A Message

On you rests, to a large extent, the hope of this Country obtaining and maintaining commercial and military supremacy in the air.

Keep in touch with our Distributors and Dealers in your territory, and see whether it will not be possible for you too to keep your hand in.

CURTISS AEROPLANE & MOTOR CORPORATION

GARDEN CITY, LONG ISLAND, N. Y.

Member Manufacturers Aircraft Association

DO YOU KNOW

the facts which forecast a great revival in the aircraft industry during 1921?

that leaders in Congress, the Army, Navy and Post Office Department are making constructive plans for aviation which should have your active support?

that AVIATION AND AIRCRAFT JOURNAL is covering more thoroughly than any other publication the current news and latest technical developments each week?

that its constructive articles on design, manufacture and operation of aircraft will give you an insight into the wonderful development of AIR TRANSPORTATION which you can secure in no other way?

SUBSCRIBE NOW

52 Issues — *U. S.--Four Dollars*
Canada--Five Dollars
Foreign--Six Dollars

GARDNER, MOFFAT CO., INC.

225 Fourth Ave. New York

AVIATION AND AIRCRAFT JOURNAL

FEBRUARY 21, 1921 — VOL. X. NO. 8

Member of the Audit Bureau of Circulations

INDEX TO CONTENTS

Editorials	227
The Jacuzzi Seven-Passenger Monoplane	228
Pursuit Airplanes Delivered	229
Import Duties on Aircraft Material	229
Strength Tests of Screw Fastenings of Plywood	230
Civilian Aviation Schools	231
Veneer or Metal Construction	232
Note on Measurements of Speed of Airplanes	233
Los Angeles to N. Y. in Two Days	234
Civil Controller of Air in Australia	234
Italian Air Service Insignia	235
Wind Tunnel Test Stations	235
Aero Engine Efficiencies	238
Book Review	240
Surveying Oil Properties	240
American Press Commends Air Mail	241
Air Driven Motor Sled	242
First Year's Result in Aircraft Underwriting	243
Aircraft Insurance	243
Test of New Air Service Engine	243
Government Aeronautical Documents	244
Therapeutics Delivered by Airplane	244
The Medical Problems of Flying	244
German Plane Inquiry	244

THE GARDNER, MOFFAT COMPANY, Inc., *Publishers*
HIGHLAND, N. Y.
225 FOURTH AVENUE, NEW YORK

SUBSCRIPTION PRICE FOUR DOLLARS PER YEAR SINGLE COPIES FIFTEEN CENTS. CANADA, FIVE DOLLARS. FOREIGN SIX DOLLARS A YEAR COPYRIGHT 1921 BY THE GARDNER MOFFAT COMPANY, INC

ISSUED EVERY MONDAY. FORMS CLOSE TEN DAYS PREVIOUSLY. ENTERED AS SECOND-CLASS MATTER NOV 22 1920, AT THE POST OFFICE AT HIGHLAND, N. Y., UNDER ACT OF MARCH 3, 1897

THOMAS-MORSE AIRCRAFT CORPORATION

Thomas-Morse Training 2-Seater in flight over Ithaca, N. Y.

THOMAS-MORSE AIRCRAFT CORPORATION

MARTIN
U.S.A.

TRADE MARK

STANDING for most great achievements there is a symbol. In the world of commerce, it is called a trade mark.

The ideal trade mark ties up to its product so unmistakably that it is a letter of introduction all in itself.

Such a trade mark is the Martin Star--a star because it represents an airplane of the First Magnitude; a star because its place is in the Sky--a star because a star is the accepted symbol of a worthy achievement.

That the Service Colors of the Martin Star are Red, White and Blue is significant, for since 1913 Martin airplanes have been faithfully serving the U. S. Government.

Thus the Martin Star has become more than a trade mark--a seal of service --a certificate of airplane craftsmanship backed by an institution which stands ready to serve Commerce just as faithfully as it has served the Government for the past eight years.

THE GLENN L. MARTIN COMPANY
CLEVELAND

Member of the Manufacturers Aircraft Association

AVIATION
AND
AIRCRAFT JOURNAL

Vol. X FEBRUARY 21, 1921 No 8

Aircraft—Our First Line

THE newspapers have given so much prominence to Gen. Mitchell's testimony regarding the possibilities of aircraft successfully attacking battle-ships that the opinion of other Air Service officers has been overlooked. Gen. Menoher has recently stated in answer to a question as to whether he was certain that the Air Service would be able to destroy battleships and put navies out of business replied "I think we are going to come to that. It is a question of development." He went further saying he believed that it was from the air alone that an invasion could be prevented. He has little fear of anti-aircraft guns as they have been notoriously ineffective or were and pilots can be relied on to penetrate and barrage.

Col Thurman H Bane has gone even farther than Gen. Menoher. He has said, "I feel right now that we can go out and put battleships out of action with the facilities we now have. We have only been at it four years, while the Navy has been developing its guns for three hundred years. Our accuracy for two hundred miles is better than their accuracy at a range of forty thousand yards."

Such testimony from the Chief of Air Service and the officer in charge of development work must be taken with the greatest seriousness.

State Air Legislation Again

THE news that a bill providing for State regulation of air navigation is to be introduced in the Senate of Kansas again serves to emphasize the sore need of a federal law of the air. However laudable the intent of the Kansas lawmakers, it cannot be pointed out too strongly how nefarious an example they would give to other States. Air navigation under state control must needs lead to friction and confusion. Aircraft travel too rapidly to be legislated upon by single states. What this country requires, if commercial aviation is to develop along healthy lines, is a national air legislation which will apply to the whole territory of the Union.

While the States of Connecticut and Massachusetts have laws affecting flying, these are rather of a general nature so that they do not actually hamper aviation. The Kansas bill, however, provides among others for the licensing of pilots and the inspection of aircraft by agents of the state.

This is, of course, a dangerous precedent. Congress should wake up to this fact before it is too late, and enact the federal air legislation the country requires.

Exaggerated Refinement in Stress Analysis

CONSTRUCTORS and designers have all learnt to use adequate methods of stress analysis. Such methods are empirical in part, some times based on aerodynamical data which are open to question, yet on the whole in concordance with the results of sand tests and of actual service. The methods have become standardized, can be readily applied, and furnish a sound basis of comparison with previous designs analyzed and tested in similar fashion.

The designer is on the whole perfectly satisfied with these methods and does not welcome innovations.

On the other hand, workers in the aeronautical field whose interests do not lie so much in design and construction as in research, criticism, specification or teaching, are always pressing for refinement and greater complexity in analysis. Their claim is that therein lies the possibility of real progress and that the adoption of more refined methods should be no hardship to the industry. For some time, they were fervent champions of the Berry method of analysis. Then again they have sought to introduce the somewhat lengthy methods of the Theory of Least Work into the structural analysis of airplanes.

In the first place it would seem to us, that in the present state of the industry, where but a few machines of any one type are used, engineering costs are already sufficiently high. An increase in complexity of method increases not only the cost of the engineering analysis on any one machine, but also the general expenses of the engineering department of a firm.

This, however, would be perfectly justified if real progress were realized thereby. The question is whether progress does in reality depend on such increase in refinement. While research men are developing methods of attack enabling designers to calculate stresses in external drift wires by the method of least work, engineers are abandoning the external drift wires, or incorporating their functions in the front lift wires. While the Berry method, with great array of hyperbolic functions and tables, is showing us how to compute stresses due to off set wire pulls, engineers are eliminating off-set wire pulls. While the most lavish attention is given to the calculation of incidence or stagger wiring of a biplane, the biplane is being displaced by an internally braced monoplane. While the laboratories are painfully analyzing the properties of veneer under every imaginable condition of stress, the designers are searching for methods of replacing veneer by the more satisfactory engineering materials, such as steel and duralumin.

While it is perfectly proper for research men in the field of aeronautics to continue their profound investigations, designers may humbly point out that a great many of these investigations are, while stimulating and interesting, simply intellectual exercises. And further, before the designers may be asked to adopt refined and complicated methods, clear ground should be shown that these methods are a real advance, and that they are not refined beyond the point of the rapid application necessary in practice, nor beyond the accuracy which can ever be attained as long as engineering material and construction are used. For these are not purely mathematical abstractions, but fallible elements almost human in their variations.

Jacuzzi Seven Passenger Monoplane

The firm of Jacuzzi Bros., Inc., of Berkeley, Cal., have designed and built the monoplane shown in the accompanying photographs. The plane is constructed for passenger carrying or other commercial purposes.

Wing Construction

By the use of externally braced monoplane construction it was possible to use a comparatively thin wing section with consequent high maximum L/D at low angles of incidence and high speed. The wings have a very heavy taper in plan from the fuselage outward to the tips. This tapering made possible the use of an airfoil section of identical proportions throughout, while at the same time, the wings could be made deep near the fuselage, which has its structural advantages. The structure is of wood and linen, the beams being larger than those used in an equivalent biplane wing and there being in each wing twelve strips which tie the webs together and add much to the rigidity. External bracing is by a Y-shaped strut under each wing, which passes from a tie-rod just back of the landing wheels to a point about two-thirds out on the wing, where it is attached to both forward and rear beam with a heavy metal fitting. These Y-shaped struts are an airfoil in section, which fact causes them to have a certain dihedral effect as they are at a considerable angle with each other. The main planes are set at a slight dihedral also. The travel of the center of pressure is small on the wing section used, and the plane has been easily recovered from a spiral nose dive as well as other positions which show that balance and other aerodynamical conditions are properly taken care of. Ailerons are placed in the trailing edge at the outer end of each wing and are actuated by a system of tubes and cranks which connect them to the dual stick-control in a very strong and simple manner.

Landing Gear

The two landing wheels are spaced with a 7-ft. tread. The wheels used are very heavy wire ones with linen streamlining applied. A two-inch axle is hung on rubber cord which allows a six-inch movement before the stops are reached. The tires are 750 by 125 mm. Streamlining in the form of an airfoil is carried between the axle and the tie rod which connects the wing struts. The leading edge of this airfoil rises with the axle on landing, the remainder not moving. The landing-gear struts are heavily made of ash and are connected at their lower end by a very large, strong fitting and join the fuselage by means of a very liberal pinned ball and socket fittings. A tube passes between the two left hand struts to serve as a step in climbing into the plane, it playing no part in the construction of the landing gear. The tail skid is a curved leaf spring.

Fuselage

The most noticeable thing about the fuselage is the way it merges into the center section. The ply-wood roof of the passenger compartment is also the upper surface of the center section and the passengers' head-room is therefore what would on most planes be the interior of the center section. This feature makes the ship appear small for its capacity to the casual observer. The fuselage is exceptionally strong and rigid at being made up of six main longerons 1-5/8 in. by 7/8 in. supplemented by eighteen auxiliary longerons 7/8 in. by 7/8 in., all supported by fourteen plywood bulkheads and covered by a plywood covering 1/4 in. thick. An aluminum casting caps the rear of the fuselage and contains bearings in which the rudder and elevators turn. Three tandem seats accommodate the seven people who make up the full load. The first seat holds two people both of whom may pilot or, by removing one of the sticks, one may pilot and the other be a passenger. The second seat holds three and the rear one two passengers. A door on the left hand side of the fuselage gives access to all seats as the left side of the first and second seats hinge out of the way.

Controls

Dual or single stick control can be used. The rudder is swung by two sets of inter-locked pedals to which it is connected by a double set of cables, entirely enclosed within the fuselage. An instrument board of mahogany mounts an altimeter, revolution counter, air speed indicator, motometer, ignition switch and oil pressure gauge. Spark and throttle levers are centrally mounted within reach of either front seat. Small levers in the roof of the pilot's compartment make it possible to give the radiator shutter any desired setting while in flight. The shut-off cocks, which will cut out either or both of the wing-mounted fuel tanks, are easily reached. A locker below the instrument board to the right holds the storage battery while a similar locker on the left is for tools etc. A dome light is in the center of the passenger compartment. The pilot or pilots have good forward vision through windshields on either side of the motor and with large openings on their outer side by which they can be wiped off if necessary. Side vision is through the windows which are to be plainly seen in the pictures.

[illegible] VIEW OF THE JACUZZI SEVEN PASSENGER MONOPLANE

Power Plant

The ship is driven by a Hall-Scott L-6 motor capable of developing over 200 hp., using Delco ignition and two Stromberg carburetors. In horizontal flight at 100 m.p.h. there is ample reserve power and that the motor is only called on for full power a very short time during any ordinary flight. The propeller used has a diameter of 8 ft. 2 in. The motor is installed with every possible precaution against fire which will be seen by consideration of the following features:— The breather fumes are carried in a long aluminum pipe clear up over the center section, eliminating any chance of their accumulating. Air comes to the carburetors through scoops which pass outside the

fuselage, thus dispensing with the back-fire danger. Overflow from the carburetors is conducted outside the fuselage by pipes. The fuel is carried in wing-mounted, copper gravity tanks which are connected to the carburetors by large copper tubes provided with flexible couplings and shut-off cocks already mentioned. Fan driven pumps deliver all fuel to the highest point in each tank thus maintaining a constant gravity head at all fuel levels.

The radiator is mounted in an absolutely unobstructed position and is of ample size. A heavy canvass shutter which can be set while in flight at any desired position, rolls up at one side of the radiator when given the wide open setting. The venturi tube of the air speed indicator is supported above the radiator out of the propeller slip-stream and all other air disturbances.

Performance and Specifications

In flight the plane proved very efficient as might be anticipated by considering the very clean design and the way every surface possible has been made to lift. The wing curve employed is another important factor toward its high efficiency. Two rather novel features which excited some criticism when the plane first appeared on flying fields were the angle strut bracing of such large wings, and the fact that the axle of the landing gear does not come at the intersection of the landing-gear struts. Actual use proved both of these objections ill-founded, as the wings are exceptionally rigid in flight and the chassis has stood up under some punishment sufficiently severe to collapse the wire wheels.

FORWARD PORTION OF THE JACUZZI SEVEN-PASSENGER MONOPLANE

Length overall	29ft.
Span	52 ft.
Height (to top of radiator)	10 ft. 6 in.
Wing area (including center-section)	400 sq. ft.
Weight empty (no fuel, oil or useful load)	1800 lb
Weight fully loaded	3400 lb
Fuel capacity (two wing tanks of 40 gal. each)	80 gal.
Oil capacity (tank in wing)	4 gal
Fuel consumption per hour	8 to 9 gal.
Radius of action	900 to 1000 miles

Pursuit Airplanes Delivered

The first airplanes to be delivered under the production orders for pursuit types have been received at McCook Field and assembled for test. The Thomas-Morse MB-3, powered with 300 hp. Wright engine of which fifty have been ordered, is being flown to insure that the construction and operation is entirely satisfactory before proceeding with the delivery of the remaining forty-nine airplanes.

The first production model of the Orenco "D" of which fifty are being built by the Curtiss Aeroplane and Motor Corp., has also been received and is being assembled to undergo acceptance tests.

Import Duty on Aircraft Material

The following table gives the import duties on aircraft material in force in the most important countries and is interesting in connection with the export development of American manufacturers.

Tariff schedules available in aeronautics are very indefinite in most countries. Rates above are those that would probably be applied. In a number of countries there are special exemptions or reductions for airplanes, but it is not always possible to tell whether these special concessions apply also to other aircraft and materials. In using the accompanying table, therefore, one should bear in mind that these rates can be taken as only approximately correct. They may, however, serve to give a general idea as to the tariff treatment of airplanes and similar apparatus in foreign countries.

TABLE SHOWING RATES OF IMPORT DUTIES OF AIRCRAFT MATERIAL INTO THE COUNTRIES INDICATED

Countries	Airplane	Balloons and Airship	Aero Engines	Instruments	Airplane Parts	Aero Engine Parts
U. S.	60 per cent Ad Valorem		20 per ct. Ad Valorem			20 per ct. Ad Valorem
France		Dutiable on a sliding scale according to component material	According to weight $1.20 to 104 fr per 100 kilos		Dutiable as component Material	
England	Free	Free	Free	Free	Free	Free
Italy	200-600 Lire each	60 Lire per 100 Kilos	12 Lire per 100 kilos		11 Lire per 100 kilos	
Germany	10 marks per 100 kilos		3.50-32 M. per 100 kilos			
Japan	Ad val. 40 per ct.	Ad. val. 60 per ct.	9-60 Yen per 100 kin according to weight		60 per cent Ad val	20 per cent Ad. val.
Chile	Free	Free	Free	Free	Free	Free
Colombia	Free	Free	$1 Free per kilo		Free	
Brazil	18.78 per cent Ad val.	15.78 per cent Ad val.	18.78 per ct. Ad val.	18.78 per ct. Ad val	Free	15.78 per ct. Ad. val.
Spain	500 Pesetas each	500 Pesetas each	40 Pesetas per 100 kilos		Dutiable as component material	
Australia	Free	45 per cent Ad valorem	178 (c) 30 per cent Ad val	*	Free	30 per cent *
Belgium		Free	12 fr. per 100 kilos according to material			
New Zealand	Free	Free	20 per cent Ad valorem	20 per cent Ad valorem	Free	20 per cent Ad valorem
Venezuela	$.60 per 100 lb.	$.60 per 100 lb.			$10.28 per 100 lb	$10.28 per 100 lb
Ecuador	Free			Free	Free	

* Suited exclusively for airplanes, free.

Normal Value, Kin 1.3228 lb., Kilo 2.2046 lb., Franc $.193, Mark $.193, Peseta $.193, Yen $.498, Lire $.200 Free (Colombia) $1.00

Strength Tests of Screw Fastenings of Plywood

By H. S. Grenoble

Engineer in Forest Products, U. S. Forest Service, Forest Products Laboratory, Madison, Wis.

Plywood in many of its uses, requires nails or screws to fasten it to a frame. The selection of the proper size of nail or screw, the spacing, and margin calls for knowledge relative to the purpose for which the plywood is to be used. If the plywood is to be used as a mere covering the size of nail or screw used or the spacing are relatively unimportant. But if the plywood must add stiffness and the stresses to be carried approach the full strength of the plywood, the size of nail or screw, spacing, and margin become important factors.

The absence of accurate data on this subject led the Forest Products Laboratory, Madison, Wis., to make an extensive series of tests on the strength of screw fastenings in 3-ply wood. These tests included the following factors: Size and kind of screw; use of washers; margin—edge of hole to edge of plywood, spacing—center to center of screws; species of plywood and of the member to which the fastening was made.

Species Grouped According to Fastening Strength. The species investigated were divided into three groups, in accordance with the strength of fastenings which they developed. The same size of screw, margin, and spacing are recommended for a given total plywood thickness for all species of any one group. Differences in strength between species of the same group were not sufficient to affect the variables appreciably.

Group I—Low density species principally conifers and such broad-leaved (more commonly called hardwood) trees as basswood, cottonwood, and yellow poplar. The recommendations are, however, applicable to other species of approximately the same density.

Group II—Medium density species. These are all broad-leaved trees. Red gum is considered the best representative of this group.

Group III—High density species. These are all broad-leaved trees and consist of those species which developed the highest fastening strength. Hard maple is a good representative of this group.

Explanation of Table. Table I presents in a condensed and easily accessible form the most important and most practical results of the study. In it are given the screw sizes, margin, and spacing for use with various species and plywood thicknesses. The gauge is the smallest gauge of screw that can be used with the thickness specified and not cause failure due to breaking of the screw when the full strength value of the plywood is developed. The length of screw is the shortest which will prevent failure in the fastening due to pulling out of the screw. The margin is the smallest margin which will insure against failure by shear. The spacing is that spacing which gave maximum strength per linear inch. Fastenings made with round-head screws without washers were found to be inferior in strength to flat-head screws without washers. Of the three combinations tested, flat-head screws without washers or round-head with washers gave the best results.

Point Where Strength Does Not Increase with Screw Length. Up to a certain point the strength of the fastening was found to increase as the length of the screw increased, but an optimum length was soon reached. Tests with screws of greater length gave no increase in strength of fastening for the corresponding increase in length of screw. The optimum length was found to vary with the density of the block into which the screw was driven. Low-density woods when used as members for receiving the screw were found to require longer screws than high-density woods. Little difference was found in the optimum length of flat-head screws without washers and round-head screws with washers.

Margins Shown Are Minimum. Tests relative to margins showed that if smaller margins than those specified are used plywood failure due to shear may occur, and that greater margins do not increase the strength of the screw fastenings since failure due to crushing usually occurs in the plywood.

Strength Varies with Spacing. Strength of fastenings per inch of width was found to increase with decrease of spacing until a minimum was reached. Spacings less than the minimum often caused failures in the plywood due to tension or splitting in the member to which the plywood was fastened.

Strength Varies with Density. The strength of screw fastenings was found to increase with the density of the plywood. This relation for any one total plywood thickness may be shown in the form of an exponential curve. This relation conforms with the strength-density laws derived from previous experiments which showed that the best criterion in selecting material possessing high strength properties is to select the heaviest pieces.

Rule for Gauge of Screw. The strength of screw fastenings was also found to vary approximately with the thickness of the plywood. An empirical rule for determining the gauge of screw for 3-ply wood of species found in Group II of thickness different from those given in the table is:

Gauge of screw to be used = 2½ + thickness of plywood expressed in twenty-fifths of an inch.

Fractional value should be considered as the next larger whole number.

For species found in Group I use one gauge smaller.

For species found in Group III use one gauge larger.

Danger of Splitting in Providing for Maximum Strength. Attention should be called to the fact that the size and number of screws required for maximum strength may materially weaken the member receiving the screw points. The data given are intended primarily as a guide in selecting the proper size of screw to give a fastening equal to the strength of the plywood. The size of member into which the screw was driven was necessarily a consideration. In all tests a size of block was selected which would insure against failure in the block after the load was applied. Until additional data are available designers must give due consideration to the liability of splitting of the frame, through too close spacing or the use of too large a screw in attaching the plywood.

Table I

PLYWOOD SCREW FASTENING SCHEDULE FOR MAXIMUM STRENGTH*

Spacing, margin, gauge (number) and length of screw to use for fastening plywood to wooden members.

Species of plywood	Thickness of plywood in inches	Gauge (number) of screw	Length of screw in inches — Species receiving point: Ash	Spruce	Margin in inches	Spacing in inches
1	2	3	4	5	6	7
Group I	3/50	4	½	⅝	[illegible]	[illegible]
	3/24	5	½	⅝	[illegible]	[illegible]
	3/20	6	⅝	¾	[illegible]	[illegible]
	3/16	7	¾	⅞	[illegible]	[illegible]
	3/10	9	⅞	1	[illegible]	[illegible]
	⅜	11	1	1¼	[illegible]	[illegible]
Group II	3/50	5	½	⅝	[illegible]	[illegible]
	3/24	6	⅝	¾	[illegible]	[illegible]
	3/20	7	¾	⅞	[illegible]	[illegible]
	3/16	8	⅞	1	[illegible]	[illegible]
	3/10	10	1	1¼	[illegible]	[illegible]
	⅜	12	1⅛	1½	[illegible]	[illegible]
Group III	3/50	5	⅝	¾	[illegible]	[illegible]
	3/24	7	¾	1	[illegible]	[illegible]
	3/20	8	1	1¼	[illegible]	[illegible]
	3/16	9	1¼	1½	[illegible]	[illegible]
	3/10	11	1½	1¾	[illegible]	[illegible]
	⅜	13	1⅝	2	[illegible]	1

Group I	Group II	Group III
Basswood	Ash, black	Ash, white
Cedar, Spanish	Ash, pumpkin	Beech
Cottonwood	Elm, white	Birch
Cypress, bald	Gum, black	Cherry, black
Douglas fir	Gum, cotton	Elm, cork
Fir, true	Gum, red	Maple, hard
Hemlock	Hackberry	
Pine, sugar	Magnolia	
Pine, white	Mahogany, true and African	
Poplar, yellow	Maple, soft	
Redwood	Sycamore	
Spruce, Sitka	Tanguile	
	Walnut, black	

* This table is based on spacing in a single row but staggering is recommended whenever possible. Consideration must be given the fact that the size and number of screws required for maximum strength will materially weaken the member receiving the screw points.

Civilian Aviation Schools

By Richard H. Depew, Jr.

Manager, Curtiss Aviation School, Garden City, N. Y.

During and subsequent to the war, much was written concerning the method of training aviators for the Army and Navy Air Services. Accepted candidates were first sent to a ground school, where for about three months they were given instruction in the theory of flight, military drill, radio communication, map reading and other military subjects. The actual flying training was given later in a series of stages, such as elementary flying (dual instruction), acrobatics, solo practise, aerial gunnery, bombing, aerial photography and formation flying. To make a good military pilot took many months; the ability to fly being only a stepping stone to the military application of the art.

The training of pilots for civilian flying presents a different problem. The essential point is to arrange a good comprehensive course which will teach the student pilot the fundamentals, and turn him out a good safe flier, and a course which at the same time can be given at a cost within the means of the average aviation enthusiast. It must also take the minimum of time, consistent with thorough training, as civilian students are nearly always either engaged in business or attending some school or university.

For civilian purposes, it is unnecessary to teach the military applications of flying. A great amount of time and expense is thus saved. A proper course should teach the student not only how to fly safely and well alone, but also give him a good foundation in the different types of airplane construction, and the theory of flight. The best results are attained by giving the theoretical instruction in a series of practical talks at the time the student is learning to fly. In this way any difficulties that are met in the air are explained in the lectures, and points brought out in the lectures are demonstrated in flight, while fresh in the student's mind.

In addition, the use of improved methods of intercommunication, enabling instructor and student to converse readily while flying, has proved exceedingly valuable along the line of better instruction and a saving of time. Several different devices were thoroughly tested out by the writer, and the apparatus used for the past two seasons in the Curtiss Aviation School has been highly satisfactory, and permits conversation to be carried on with ease at all times while flying. Such a device not only proves very valuable for training purposes, but adds tremendously to the pleasure of flying. It is exceedingly simple, with no parts to get out of order. A most important point is to provide facilities enabling the student to continue his solo practise, under the observation and criticism of an instructor, after he has successfully completed the regular course of dual instruction.

Safety the Cardinal Point

In the above discussion considerable emphasis has been laid on safety. Safety is the cardinal point in civil aviation. This is a large enough subject in itself for treatment in a separate article. Suffice it to say that flying, properly done, now entails very little risk indeed. This means a careful, capable pilot, flying a good machine under reasonable conditions, and exercising good judgment. The safety of flying is assuredly not demonstrated by the publicity seeker, who in attempting to prove his prowess and skill, tailspins his plane into the ground from a low altitude. Nor, is the public encouraged to take up flying by having their hats blown off by the backwash from the propeller of someone pursuing the exciting pastime of "hedgehopping".

In almost any subject studied, the pupil reflects to, a greater or less degree, the work of his instructor. This is particularly true of flying. The teaching of men—and women, for they are taking it up in increasing numbers—to fly, imposes a great responsibility upon the instructor. Careless or unsound teaching may result in trouble to the student later on, as all good pilots realize. On the other hand, few things are more gratifying than the feeling of justifiable pride on the part of the flying instructor who takes a real interest in his work, when his student "makes a good solo", and does creditable work thereafter.

The student pilots at a civilian aviation school come from all occupations and walks of life. A very small proportion has had any technical training. Starting at the beginning, the work at a good school is taught one step at a time, and great care is taken to see that each student receives individual explanations of any difficulties he may have, in addition to the class-room work. The aim constantly kept in mind is to drill the student in the art of flying correctly, and the reasons for everything taught. For the benefit of all students, the lectures should be made simple and not too technical to be understood by all. Some, of course, make better pilots than others, but with present day machines and the proper interest in the work, the man who absolutely cannot learn to fly is exceptional. With average intelligence and physique, nearly anyone can become at least a safe pilot, even if not a brilliant one.

The instinctive ability to move the controls correctly at the right time is quickly and easily learned. The difficulties of landing are mastered in a surprisingly short time, when one considers what an entirely new and different experience to the human race is the navigation of the air. What, then, is the really big difficulty in learning to fly? There is none.

Common Sense

Of course, there is only one way to become an experienced pilot, and that is by getting much actual flying experience. But this does not consist wholly of just getting "time in the air". Beyond a certain point, hours in the air upon any one given type of airplane, do not bring a proportionate benefit in experience. A really good pilot who has flown many different types of planes, is often much more experienced than the man who may have had hundreds of hours more in the air, but upon only one or two types. The big thing that cannot be taught in any flying school, the quality that often spells the difference between success and failure, is common sense. Learning to fly is a matter of dollars and sense; you need a comparatively few dollars to take a course, but you need all the sense you have to continue successful flying. Were this not so, it would lose much of it's fascination.

Contrary to common opinion, recklessness and speed mania are not desirable qualities in the would-be aviator. Granted that in war a certain devil-may-care spirit was sometimes desirable in the flier, in peace-time aviation care and cautiousness are prime requisites. As for a fondness for speeding motor cars and the ability to drive them being of assistance in learning to fly, one has only to realize that, except for a very few seconds when leaving or approaching the earth, there is no sensation of speed in an airplane, to appreciate it's uselessness. There is a thrill in flying—none better—but it is more a feeling of great exhilaration and a sense of power and mastery than anything else.

There is a great number of splendid pilots in the country today, but all good pilots recognize the fact that there is also a surprising number who continue, more or less, to "get away with it more by good luck than good management". The successful aviator cannot fail to realize the very great importance of exercising good judgment at all times in his work. This should be the subject of much study. A little more care in this matter would eliminate a big percentage of what very few accidents still occur. An aviator's true worth can be judged far better from the manner in which he leaves and approaches his landing field—whether he plays it safe or takes unnecessary chances—than from a display of any amount of acrobatic ability. It is to be understood that these remarks apply to civilian flying.

To those who have not yet flown, it is well to explain that there is nothing in the least terrifying in the sensation of ordinary flying. This is attested to by the unfailing enthusiasm

of passengers. Nor need one have the slightest fear of a sense of dizziness or illness such as is usually experienced by anyone looking down from a high building. In an airplane, there is absolutely no such sensation from even very great heights. Flying is wonderfully pleasant and exhilarating, and the seat under one feels just as solid as that in a motor car, but without the jolting and jouncing of the latter.

A pilot should understand his machine. While history shows that some exceedingly skillful aviators knew next to nothing about their planes and engines, nevertheless the man who knows is always more valuable. Sooner or later his knowledge will stand him in good stead, and any good course of instruction should include careful explanation of such matters. In any occupation, better work is always done when the underlying principle is understood. And the more one understands about aviation, the more fascinating the subject becomes. And the science is still in its infancy.

The question is often asked: "Why are people learning to fly, in a time of peace, when there are already so many good pilots, trained during the war?" And also: "Who are taking it up?"

There are a number of reasons why people are learning to fly. Some are purchasing machines at moderate prices, and making a business of passenger carrying, aerial advertising, aerial photography which is growing in popularity, and kindred uses. Some learn purely for sporting reasons, as many well-to-do people first took up the automobile in its early stages of development. But the chief reason is the fact that young men are realizing the very great future ahead of the aeronautic industry, and wish to start in it as a business while it is yet comparatively in its infancy. There is no better and quicker way of obtaining a broad foundation in the thorough knowledge of the subject, from both the theoretical and practical sides, than by taking a course in flying at a good aviation school. The biggest men in the industry today, the heads of airplane companies in this country and abroad, have been pilots themselves. Aeronautical engineers are finding it advisable to learn to fly, so that they can view their problems from the standpoint of the user of the product which they are designing. Of course, by no means the least reason is on account of the pleasure it affords.

Since the war the Curtiss Aviation Schools have had students from all sections of the United States, Canada, Italy, Greece, China, Mexico, Guatamala, Panama, Colombia, Peru, and the list includes several women. An interesting observation is that women are, if anything, more enthusiastic passengers than men.

A big burden of responsibility rests upon the civilian flying schools today. The growth of aviation depends upon the increasing use of airplanes. This means more and more pilots, and they have to be trained. Whether or not they are properly trained rests with the schols. It is a privilege to initiate new men into the art of aviation. Let us not forget that it is our duty to spread the slogan of safety and to do our work well, if we would help to hasten what is inevitably coming—the universal use of the newest and fastest means of transportation, with it's limitless possibilities—the navigation of the air.

Veneer or Metal Construction

By William B. Stout

There is considerable talk among airplane designers, both in America and abroad, regarding the next step in materials used for airplane constructions. It is pretty generally accepted as a fact that the fabric-and-wood type of construction, as used during the war, is not satisfactory for commercial ships, from the standpoint of operation and first cost, alone.

Veneer Construction Suggested

In a report on progress of the London and Paris Line for the Airco Co. of England, Frank Searle, the operations manager, states that in his opinion the next step will be in veneer construction—thin wood sections suitably arranged and finished to give proper strength and contour for airplane work. In his belief, as in his written report recently published in England, the new planes will be monoplanes, having all veneer internally-trussed wings above and streamline fuselage hanging beneath the wings, with passengers enclosed out of the wind and air; with one engine of extreme reliability, and with method of quick disassembly of the entire ship for replacement of parts, engine, etc., from the service standpoint.

In discarding fabric and wood constructions, it is natural that firms which have been producing planes of this type should be attracted by the veneer construction, since the type of workmanship is nearly the same and organizations can be kept intact. For the reason that these firms are starting to use veneer and plywoods, it is only natural, too, that they should more or less question developments in all-metal, rather than of the prevailing veneer construction.

Both types have their special advantage. For experimental planes and planes in small quantities, veneer can be very well used in internally-trussed types of ships, and has the advantage of quick production and ease with which changes may be made from the original. Newer design and development makes these changes imperative. In the metal, these changes are very much more difficult to accomplish, and firms naturally hesitate to go to great expense on tools and dies for metal work, when they feel that very few ships of the same type will be built.

All-metal construction, however, has very many things to commend it above the veneer, once it is developed. In the first place, it is more waterproof, and the newer duralumin alloys are not affected by salt water.

An airplane may travel on a hot August day from a ground level of 100 in the shade and 20 minutes later may be in almost zero temperature, or may be accidentally caught in a rain storm. Veneer is as yet an untried proposition. It is probably better than fabric-and-wood, as now used, but as to the longevity of planes so constructed, this would largely be dependent upon the extreme temperature changes to which the construction was subjected. The usual waterproof glues tend to become brittle on very hot, dry days, and soften up slightly on very damp days, which cannot help but make a changeable structure. It is doubtful if veneer airplanes could be used at all along the Mexican border, and in similar climates.

The all-metal machine is undoubtedly more experimental, and involves a greater development cost, but once produced, its depreciation should be almost nothing, in fact, no more than in a motor car. These planes, having no adjustments nor changes, would, of necessity, be cheap to operate, with few mechanics.

As between steel and duralumin for airplane constructions, the latter is generally favored, since for the high alloy, the steel sections used become so very thin that they are easily bent or damaged by very small bumps, thus losing their strength, whereas the duralumin has a great enough cross-sectional area to form a much more permanent structure, although the factor of safety may be the same.

American Duralumin Superior to Foreign Products

It is interesting that duralumin, as made in America, has shown up even better than the best foreign metals of the same class, the heat-treating process being more accurate, and the alloys slightly superior in their physical test characteristics.

A few firms in America are working on the veneer construction, and only one or two on all-metal construction, but the end of next summer should see a more or less definite conclusion on the part of American designers as to which of the two constructions will dominate the commercial airplane field.

Note on Measurement of Speed of Airplanes

By S. Herbert Anderson

Ass't. Professor of Physics, University of Washington, and Consulting Physicist, Engineering Division, Air Service, U. S. A.

In a recent paper Dr. J. G. Coffin* calls attention to the fact that in airplane speed trials over a measured course it is generally considered necessary to wait for a time when little or no wind is blowing, or if any, that it be along the course. He then goes on to show that, theoretically, such a procedure is not necessary, and gives a method for finding the true airspeed of an airplane from data secured by timed flights over a measured course *when there is wind*. The data required consists of (1) the time necessary for a flight in each direction over the course at a constant airspeed and (2) either the heading of the airplane with reference to the course or the magnitude and direction of the wind.

The writer has had considerable experience in carrying out speed trials of airplanes at Langley Field. Early in the work numerous attempts were made to conduct the tests during windy weather and to compute the airspeed by methods similar to Dr. Coffin's. A Meteorological Station of the Signal Corps situated near the course furnished reliable data on the wind at the time of the flights. For each speed trial from four to eight flights were made over the course at the same airspeed. Invariably, if the wind was more than about 10 m.p.h., the data from successive pairs of flights gave very discordant values of the airspeed, so that finally all attempts to make speed tests during windy weather were abandoned. It was found desirable that the air be as quiet as possible, both free from gusts and of low wind-speed, to secure which it was often necessary to make the trials early in the morning or in the evening.

The equation which Dr. Coffin obtains are given here for reference

$$V^2 = \frac{(U_1 + U_2)^2}{2} + \frac{(U_1 - U_2)^2}{2}\tan^2\alpha \quad .. \quad (6)$$

$$W^2 = \frac{(U_1 - U_2)^2}{2} + \frac{(U_1 + U_2)^2}{2}\tan^2\beta \quad .. \quad (7)$$

* Aviation and Aeronautical Engineering Aug. 15, 1920.

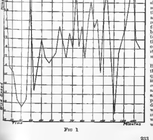


Fig. 1

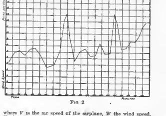


Fig. 2

where V is the air speed of the airplane, W the wind speed, U_1 the ground speed of the airplane (obtained from the time of flight) in one direction and U_2 the ground-speed in the opposite direction, α the angle that the wind makes with the course, and β the angle the heading of the airplane makes with the course. In the derivation of the above equations he assumes (1) that the wind is constant and (2) that the airspeed of the airplane is constant. An examination of the record of a surface wind made by a recording anemometer will show that the wind is anything but constant, *fluctuations occurring within five minutes which are 50 per cent to 100 per cent of the mean wind speed*. These fluctuations are illustrated by Figs. 1 and 2, which were drawn from anemometer records taken at the University of Washington, Sept. 12 and 13, 1920, and were selected to show the variations in speed of a moderate and slow wind respectively. In Fig. 1 the maximum variation is 13.3 m.p.h. in 8 min., while the mean wind speed is about 19 m.p.h. In a slow wind the fluctuations are smaller in magnitude and less frequent as shown in Fig. 2, while in winds for higher speed they are much greater. Unfortunately for the purpose of this paper these figures do not show the fluctuations as great as they actually are, since the Robinson anemometer, by which the records for these figures were made, indicates the time required for the wind to travel one mile. During this time there may be fluctuations very much greater than the variations in the times for the wind to travel successive miles. Furthermore, the above figures show nothing of the variation in the *direction* of the wind. In order that equations (6) and (7) be valid it is just as necessary that the wind be constant in direction as in magnitude.

In his report on "Meteorology and Aeronautics"* Major Blair states that accelerations in the horizontal component of the wind speed ranging from 7.5 to 30 cm./sec./sec. are frequently observed. Taking the latter value, which is approximately 1 ft./sec./sec., such an acceleration acting for *only one second* would produce a change in the wind velocity amounting to more than 1 per cent of the airspeed of an airplane flying at 60 m.p.h. If this wind acceleration were parallel to the course it would make the ground-speed in one direction approximately 1 per cent different from what it would be with a constant wind velocity and affect the determination of the airspeed by ½ per cent. If the wind velocity were "across" the course, the effect of the wind acceleration would be less.

* Report No. 13, N. A. C. A., 1917

While in the above illustration the value of the wind acceleration used is large, the time interval, one second, is *small*. Generally the duration of a wind acceleration will be for several seconds, or a minute or more, and the magnitude of the change in velocity of the wind will be the *time integral* of the acceleration, which will be, consequently, considerably larger than the value used above. If the acceleration lasted for *only 10 sec.*, it would cause an error of 5 per cent in the airspeed measurement.

Furthermore, horizontal accelerations of the wind cause variations in pressure on the wings of the airplane, which together with vertical currents are the cause of "bumps", so common at low altitudes. Since in any speed trial it is necessary to fly the airplane near the ground and as level as possible, any variation in the sustaining force adds to the difficulty of maintaining a constant airspeed, and hence is a source of error in the speed determinations.

If the fluctuations of the wind were rapid enough, the effect of the positive accelerations would balance the negative. However, an examination of an anemometer record, such as Fig. 1, shows that the period of the fluctuations is comparable to the time required to fly the course, (from two to five minutes), so that it would be quite possible to have a positive acceleration while flying in one direction and negative while flying in the opposite. *It is apparent then, that the inherent nature of a surface wind is quite contrary to the first assumption, and indirectly makes the second assumption untenable.* That is, in a moderate wind, 10 to 20 m.p.h., neither the wind nor the airspeed of the airplane are sufficiently constant to render Dr. Coffin's equations serviceable.

It may be pointed out in this connection that less error will result when a variable wind is "across" then when along the course. Perhaps this can best be shown by a numerical example. Assume that the true airspeed is 80 m.p.h., and that for one flight there is a wind of 8 m.p.h. at right angles to the course and for the flight in the opposite direction the wind is 4 m.p.h. at right angles to the course. The observed ground speed for the first flight will be 79.6 m.p.h. and for the second 79.9 m.p.h. The airspeed as computed from equation (6), assuming a constant wind of 8 m.p.h. is 79.75. Hence the error in determining the airspeed from the ground-speed and wind is only ¼ m.p.h., or about 0.3 per cent. Now assume that the wind is parallel to the course and for one flight is 8 m.p.h. and for the other 4 m.p.h. The observed ground-speed will be in this case 88 m.p.h. and 76 m.p.h. respectively, and since the angle the wind makes with the course is zero, the computed airspeed will be the mean of 88 and 76 or 82 m.p.h. Hence the error is 2 m.p.h., or 2.5 per cent. Therefore, if a light, variable wind is blowing, *less error* will be made in determining the airspeed when *the wind is across the course than when along the course.* When the wind speed is high the error with the cross wind will probably be as large as with a parallel wind, because of the difficulty of "crabbing" along the course, that is holding the ship's heading so that the course made good will be along the measured course.

The second method described by Dr. Coffin, (taken from a British report, see Fig. 6 of his paper) is very attractive until one tries to use it, and in practice is also subject to several sources of error. The wind must be constant in order that this method may give the correct airspeed, and since more time is required to make three flights than two, the chances for wind fluctuation and error are greater, unless the flights are made at such an altitude that the wind will be constant. Such conditions hold above 5000 ft., but with flights at high altitudes it is necessary to use optical means of sighting the airplane and determining the ground-speed. The camera obscura is specially useful for this work. A light-tight room about 8 ft. square and 8 ft. high, with a good photographic lens of large diameter in the center of the ceiling serves very satisfactorily for this purpose. A horizontal plotting board is placed in the principal focal plane of the lens, and the intersection of the principal axis with the board marked. The airplane is flown over the camera obscura at a constant airspeed and level. The image of the airplane moves over the plotting board in the opposite direction to the actual motion of the airplane. If the speed of the image is determined, then the speed of the airplane is given by $S = s\frac{H}{f}$, where S is the speed of the airplane, s the speed of the image, H the altitude and f the focal length of the lens. The speed of the image is best determined by plotting the position of the image for equal intervals of time, say every second, or two seconds. For this, accurate time signals are required which may be obtained by having a telegraph sounder operated by a chronometer or clock.

The uncertain factor of this method is the *altitude*. This should be constant for two reasons: (1) that the ground-speed may be computed by the simple equation given above, and (2) that the wind be constant. The wind varies considerably with altitude, and at times a change of 50 to 100 ft. causes a marked difference in the speed. To enable the pilot to keep a constant level the altimeter should have as open a scale as possible, so that a small change in altitude may be quickly indicated. Assuming that the pilot maintains a fairly constant altitude, the determination of this is somewhat uncertain. Aneroid barometers (altimeters) are at best rather unreliable instruments so that the calibration of the instrument should be made immediately after the test flight in order that the instrumental errors may be known with some degree of certainty. In the next place, the reading of the instrument must be corrected for the temperature of the air. The altitude-pressure tables, by which altimeters are calibrated are computed on the basis of an isothermal atmosphere. In the tables prepared by the Bureau of Standards 10 deg. Cent., is taken at the standard temperature. If, in using an altimeter, the mean temperature of the air column is higher than 10 deg. Cent., the indicated altitude will be too low, while if the mean temperature is less than 10 deg. Cent., the indicated altitude will be greater than the true altitude. The true altitude may be obtained from the one indicated (altimeter reading corrected for instrumental errors) by multiplying by $\frac{T_m}{283}$, where T_m is the harmonic mean absolute temperature, and is equal to $\frac{n}{\frac{1}{T_1}+\frac{1}{T_2}+\dots\frac{1}{T_n}}$ where T_1, T_2, etc., are the absolute temperatures of the air taken every thousand feet above the surface of ground. If the altitude is not too great, the arithmetical mean is practically the same as the harmonic mean and may be used.

The probable error in determining the air speed by this method is not less than 3 per cent. In the first place it requires a very skillful piloting to hold the airplane at a constant altitude during the test, and a variation of 50 ft. is quite possible, which at 5000 ft. altitude makes 1 per cent error. In the second place, instrumental errors of 1 to 2 per cent are quite possible. And third, the correction of the indicated altitude for temperature is subject to some error, probably of the order of 1 per cent or more. Under the most favorable circumstances these errors cannot be entirely eliminated. Hence of the two methods here described, the first is to be preferred, since with sufficient care the errors can be kept within smaller limits.

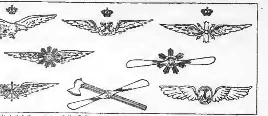
Los Angeles to N. Y. in Two Days

J. D. Cadney of the Ingersoll-Rand Company, New York, received a letter from his wife dated Jan. 24, 1921, at Los Angeles at the Engineers Club in New York at 5.30 p. m. Jan. 26. This letter could have come through in this time by no other method than the Air Mail as it was in reply to a letter which was written on Jan. 17. This instance of expediting the mails is one of many, but as no air mail stamp is used it is not brought to the attention of the recipient.

Civil Controller of Air in Australia

The Federal Government has appointed Colonel Brinsmead to the office of Controller of Civil Flying. Australian airmen have been eagerly awaiting the appointment of a Civil Controller who will organize and announce air navigation regulations.

Italian Air Service Insignia



Herewith are illustrated the insignia of the Italian Air Service. In the top row, on the left is the insignia worn by seaplane pilots, in the middle that of airship officers, and on the right that of aerial observers. Enlisted men wear these insignia without the crown, the latter indicating an officer. With regard to the insignia of airship officers, commanders of medium and large airships have a gold crown on red foundation, first lieutenants have a plain gold crown; all other airship officers have a silver crown. All the above insignia are of gilt metal, except where otherwise specified.

The insignia shown in the middle row are those worn by aeronautical engineers and engineers, respectively. They too are of gilt metal.

In the bottom row the insignia on the left is for airship helmsmen, that in the middle is for aircraft workmen (fitters and riggers), and that on the right was issued during the war to enlisted men of the American Expeditionary Forces serving with Italian units.

Wind Tunnel Test Stations

Wind tunnels for testing aircraft models, propeller sections, wing sections, struts, and streamline bodies are located at the following places:

National Advisory Committee for Aeronautics, Langley Field, Va., Bureau of Standards (2), Washington, D. C., Navy Yard (2), Washington, D. C., Army Air Service, McCook Field, Dayton, O., Curtiss Engineering Corporation (2), Garden City, L. I., Massachusetts Institute of Technology, Boston Mass., Leland Stanford Junior University, Stanford University, Calif., Throop College of Technology, Pasadena, Calif., State College of Washington, Pullman, Wash.

The facilities of the Government wind tunnels are available for the conduct of tests for private individuals or corporations at cost, when the process of official work does not prevent. For tests in Navy wind tunnels, communications should be addressed to the Bureau of Construction and Repair, Navy Department, Washington, D. C. The aeronautic facilities of the Bureau of Standards have been placed at the disposal of the National Advisory Committee for Aeronautics. Parties desiring to have tests made in the wind tunnels at the Bureau of Standards or at Langley Field should communicate direct with the National Advisory Committee for Aeronautics, Washington, D. C. For tests in the other wind tunnels listed, communications should be addressed to the heads of the various establishments.

It is suggested that designers avail themselves of expert advice before going to the trouble and expense of having models prepared for test, for unless models show evidence of improvement over devices already in use, and appear entirely practical, same will not be given serious consideration, either by the Government or by commercial concerns. Models must be accurately made, but attention is called to the fact that this is extremely difficult. Inexperienced parties should first consult Technical Report No. 74, of the National Advisory Committee for Aeronautics, entitled "Construction of Models for Tests in Wind Tunnels."

Inventions and new appliances in the field of aerodynamics may be submitted to the National Advisory Committee for Aeronautics, Washington, D. C., complete with drawings, descriptive matter, and such photographs as may be necessary. Its committee of Aerodynamics will arrange for test at Government expense, at any of the Government laboratories, of such devices as it may approve. Unless a device has passed the research stage and offers prospects of immediate value for use in military or commercial aircraft, the Government will not test same at its expense. On the other hand, if a device shows sufficient promise of development, the Government will bear the expense of test and of further development. Models rejected for test at Government expense may be tested by the Government at the designer's expense.

Designers should submit blue prints and drawings to the Director of Air Service, only when such articles submitted are of standard and approved construction, and not in any way in the nature of inventions. Until an airplane or engine has been developed and produced by the owner or designer and its advantages so demonstrated that a purchase of same is contemplated by the Government, the laboratories and technical staff of the Army Air Service, are not available for testing or carrying on experiments with regard to same.

In the case of inventions and unpatented material submitted to any War Department Office, War Department orders direct that all such be forwarded to the Inventions Section, Operations Division, General Staff, State, War and Navy Building, Washington, D. C.

There are no government funds available to render financial aid to new enterprises or to develop private inventions.

In addition to the university laboratories referred to, several colleges are taking up the study of aircraft design and construction, and have well-equipped laboratories in connection therewith, but this work is educational and not under the supervision of the Government. Several aircraft manufacturing concerns also have their own experimental departments.

A DECISION THAT VITAL FFECTS EVERY PILOT *AND* THOSE WHO WISH TO MAKE EY IN COMMERCIAL AVIATION

When the United States Navy decided to sell a limited number of HS2 Coast Patrol flying boats, fitted with the famous 350 H. P. Liberty Motor, at less than one-third of their original cost, an opportunity to make money in commercial aviation was offered to those interested in aeronautics that probably will never occur again.

In choosing the AEROMARINE ENGINEERING & SALES CO., as the channel for the distribution of these boats to the public, the Navy Department made it possible for purchasers to take advantage of the experience gained by the investment of hundreds of thousands of dollars in successfully operating AEROMARINE flying boats for commercial purposes.

Aeromarine-Navy HS-2-L Six Seat, Open Cockpit Flying Boat, Model No 80
Price $6,500 00 Immediate delivery

This open cockpit sport model is ideal for aerial photography, timber scouting, forest patrol work, locating schools of fish for commercial fishing, commuting between city and country homes, and for any purpose requiring speed, safety and comfort.

AEROMARINE SALES SERVICE INCLUDES THE SECURING OF RELIABLE PILOTS AND MECHANICS.

Aeromarine

With the present low prices of these AEROMARINE HS2 flying boats anyone, wherever there is water, can make money. The operating cost for fuel, mechanic and pilot is about $16.00 per flying hour and the possible revenue is from $250. to $300. per flying hour. This shows a handsome profit after allowing liberally for overhead and depreciation.

Men of vision everywhere realize there is big money in commercial aviation and that it is the transportation of the future. Now, that reliable equipment can be purchased for less than one-third of its actual worth - this is an opportunity you cannot afford to overlook.

Aeromarine-Navy HS-2-L Enclosed Cabin De Luxe Flying Limousine, Model No 80
Price $9,000 00 Immediate delivery

This flying limousine will more than pay for itself as a feature attraction for amusement parks, resort hotels, sight-seeing trips, or for regular passenger or mail carrying.

AN EASY PAYMENT PLAN MAKES IT POSSIBLE TO PAY FOR THESE BOATS, IN PART, OUT OF THEIR EARNINGS

Aeromarine

Aeromarine Engine g & Sales Co., Inc.

1800 TIMES BUILDING **PHONES B 505 or 6147** **NEW YORK CITY**

Aero Engine Efficiencies*

By A. H. Gibson, D.Sc., M.Inst.C.E., M.I.Mech.E.

By the efficiency of a petrol engine, one usually understands the thermal efficiency, or the ratio of the heat returned as work on the crank shaft, to the heat energy in the fuel. This efficiency is vitally important in an aero engine intended for long-distance work, since it directly affects the weight of fuel to be carried.

The necessity for a high thermal efficiency on the b.hp. involves that of a high mechanical efficiency, that is it requires that the losses due to mechanical friction and to pumping losses shall be small.

But an engine may have a high thermal efficiency, and yet have a comparatively low brake mean effective pressure. It may, owing to too small a valve area or to poor design of the induction system, only be able to draw a small weight charge into the cylinder, although it may use this very efficiently once it is in the cylinder. Its volumetric efficiency is low, and this is directly felt as a proportional increase in the engine weight per hp. In an engine for a light scouting machine, required to carry petrol for a two-hour flight, and weighing about 2½ lb. per hp., an increase in volumetric efficiency leading to a proportional increase in the b.hp., is practically twice as valuable as the same percentage increase in thermal efficiency with no increase in the power.

There is still another respect in which aero engines vary appreciably and that is in their relative performance at height. Two engines giving the same performance as regards output per unit of weight and petrol consumption per h.hp. on the ground may give very different performances when operating under altitude conditions. The smaller the falling off in power with height and the greater is what, for want of a better word, may be called the altitude efficiency of an engine.

These various efficiencies are affected by the design and conditions of operation of the engine. During the last four years much experimental work has been done on aero engines and a good deal of data has been gained bearing on this question. The data embodied in this paper are, in the main, the results of tests carried out by the author and his colleagues between 1916 and 1919 at the R.A.E.

Mechanical Efficiency

The mechanical losses in a petrol engine are due to:

1. Bearing friction, and to driving of valve gear and auxiliaries.
2. Piston friction.
3. Fluid pumping losses.
4. Windage losses (in rotary engine).

Strictly speaking the last two are not mechanical losses, but are usually included under this head.

The total loss in an ungeared static engine of modern design at normal speed, and full load, may be taken as equivalent to between 10.5 lb. and 14.0 lb. per sq. in. of piston area, the lower figure referring to radial air-cooled engines, and the higher to water-cooled engines. Taking 120 lb. per sq. in. as a reasonable value for the B.M.E.P., these values correspond to mechanical efficiencies of 92.0 and 89.5.

From experiments it appears that the mechanical efficiency of the rotary engine, even if well cowled, is some 10 per cent less than that of the corresponding fixed radial engine.

Volumetric Efficiency

Defining volumetric efficiency as the ratio of the volume at normal temperature and pressure (0 deg. C. and 760 mm. of mercury) of the charge entering the cylinder per working stroke to the volume swept by the piston, it is evident that the volumetric efficiency which is possible in a given engine, depending as it does on the pressure and temperature at which the charge actually enters the cylinders, will depend not only upon the cylinder design and temperature, but also upon the pressure and temperature of the surrounding air.

As these may vary over a wide range during the operation of an aero engine, they should always be specified when questions of volumetric efficiency are involved.

For a given air pressure and temperature, say N.T.P., the pressure and temperature of the charge in the cylinder at the end of the suction stroke are affected by

(*a*) The resistance to flow through the induction system and valves.

(*b*) The cooling effect of petrol vaporization in the carburetor and induction pipe.

(*c*) The temperature of the cylinder walls, piston, and valves.

(*d*) The compression ratio.

(*e*) The pressure of the residual products of combustion left in the clearance space at the end of the exhaust stroke.

(*f*) The valve timing.

Maximum Possible Volumetric Efficiency

Under favorable circumstances the volumetric efficiency may be expected to obtain a value as high as that corresponding to the volume ratio enclosed at the instant of valve closure, and if the closing angle of about 45 deg. late be adopted as the minimum angle for normal high speed operation, the corresponding volumetric efficiency would be 88 per cent.

As values of .85 have been measured on air-cooled cylinders with a valve timing giving an inlet closure of 45 deg. late, and as values of .92 have been obtained at comparatively slow speeds with a closure 30 deg. late, such a value would appear to be not impossible of attainment in practice.

While volumetric efficiencies of well over 90 per cent are on record with late valve closures, such values can only be attained at speeds where the pressure pulsations in the induction or exhaust pipe assist in increasing the effective induction pressure, or in reducing the exhaust pressure.

Measured values of the volumetric efficiency for a number of engines all of which refer to normal temperature and pressure, were found to range between .70 and .85.

Thermal Efficiency

In an internal combustion engine using a working fluid whose specific heat is independent of temperature, it may readily be shown that the ideal thermal efficiency is given by the expression

$$y = 1 - (1/r)^{\gamma - 1}$$

where γ is the ratio of the specific heats at constant pressure and constant volume, and r is the compression ratio. In the case of air γ is 1.408, so that the expression for this "air cycle efficiency" is

$$y = 1 - (1/r)^{.408}$$

Corresponding values of this r and γ are shown in lines 1 and 2 of the following table and in the upper curve of Fig. 1.

Owing to the fact that the specific heat of the mixture in a petrol engine increases with temperature, the maximum temperatures are less than would be attained with this ideal working fluid, and the possible thermal efficiencies are less than are given by the above expression.

TABLE

1	Value of r	4.0	4.5	5.0	5.5	6.0
2	Air Cycle Efficiency on 1. hp.	.431	.459	.480	.501	.518
3	Ditto with variable specific heat	.364	.386	.402	.420	.433
4	Ditto calculated on b.hp.	.328	.348	.364	.378	.390
5	Petrol, lb. per b.hp. hr. equivalent to efficiency (4)	.416	.392	.376	.361	.350

Taking into account the variation of specific heat with temperature, as well as our present knowledge permits, the possible thermal efficiencies with the best air petrol mixture become as shown in line three of this table. These values are calculated on the 1. hp. Assuming 90 per cent as the mechanical efficiency of a good modern aero engine, the possible thermal efficiency calculated on the b.hp. has the value shown

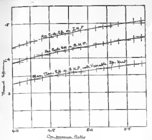


FIG. 1

in line 4 and in the lowest curve of Fig. 1. These are the highest values which could be attained in a petrol engine working on the constant volume cycle with no heat losses to the cylinder walls, with complete combustion of fuel, and with expansion down to the end of the stroke. The corresponding petrol consumptions are given in line 5 of the table. Brake thermal efficiencies corresponding to various petrol consumptions are shown by the curve of Fig. 2.

Experiment shows that the best modern aero engines are capable of operating on from .50 to .55 pints (.452 to .497 lb.) of petrol per b.hp. hour with compression ratios in the neighborhood of 5.0. The lower figure is exceptional, but has been attained under normal running conditions. A consumption as low as .49 pints (.444 lb.) has been attained in single cylinder tests on an air-cooled 5½ in. x 6½ in. engine at the R.A.E.

Typical test results which have come under the author's personal notice are divided into two parts, the first giving the best maximum load results for water-cooled and air-cooled engines, and the second the best weak mixture results. While conventionally adopted, the nominal value of r based on the piston displacement and the piston volume is not the real compression ratio. If compression be assumed to commence when the inlet valve closes, and if the compression ratio be calculated on the volume shut in the cylinder at this point, a value is obtained which probably more correctly represents the true ratio.

Using the latter figures as the basis of comparison, it appears that the best water-cooled engines are giving 79 per cent of the possible theoretical efficiency on a maximum load mixture and 84 per cent on a weak mixture. The best air-cooled engines give 82 per cent on a maximum load mixture and 91 per cent on a weak mixture. The best air-cooled results have been obtained from single cylinders. Tests indicate that the weak mixture efficiency of a multi-cylinder engine is less than that of the individual cylinders of which it is comprised. The difference depends on the efficiency of the induction system, but in the average 12-cylinder Vee is from 8 to 10 per cent, so that the weak mixture relative efficiency of the corresponding best air-cooled multi-cylinder engine would be almost exactly the same as that of the best of the water-cooled engines.

The average maximum load relative efficiency for the whole of the water-cooled engines is 75 per cent, and for the whole of the air-cooled engines having aluminum cylinders is 75.5. The average relative efficiency on weak mixtures is 81 per cent for the water-cooled and 87.3 per cent for the aluminum air-cooled engines. The results indicate that as regards thermal efficiency there is practically no difference between the best air-cooled and the best water-cooled engines. They also show that the best engines are remarkably efficient and leave little scope for further improvement in the way of thermal efficiency if operated on reasonably weak mixtures.

Conclusions

The general conclusions to which this paper would tend are:

(1) The mechanical efficiency of a well designed water-cooled line engine, having direct drive, should not be less than about 89 per cent at full load. In the same engine, if geared, it should not be less than 83 per cent. The static radial air-cooled engine may, in general, be expected to give mechanical efficiencies about 3 per cent higher, and the rotary air-cooled engine, if well cowled, about 10 per cent lower.

(2) The volumetric efficiency, owing to the cooling effect of petrol vaporization, is higher than in the corresponding gas engine. This cooling effect appears sensibly to counter balance, the heating effect of the cylinder walls, piston, and inlet valves. With short induction and exhaust pipes, the volumetric efficiency is mainly governed by the inlet valve timing. Under normal conditions of operation, a volumetric efficiency of 88 per cent is about the maximum to be expected. The value increases with the compression ratio, and is appreciably reduced by any back pressure in the exhaust pipe.

(3) The thermal efficiency increases with the compression ratio, within limits. The compression ratio giving maximum efficiency depends on the cylinder design. In a well-designed air-cooled engine with aluminum cylinders operating under ground conditions it is in the neighborhood of 5.2. In a well-designed water-cooled engine it is a little higher, apparently between 5.5 and 6.0. The thermal efficiency on maximum load, for compression ratios below about 5.0 in a good air-cooled engine, and 5.4 in a good water-cooled engine, increases more rapidly with increased compression ratio than does the expression for the air cycle efficiency. This is due partly to the reduced wall losses, and partly to the accompanying increase in mechanical efficiency.

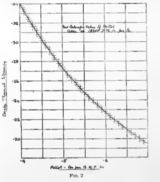


FIG. 2

* Extracts from paper in the *Transactions of the Royal Aeronautical Society*

Taking the physical properties of the working fluid into account, the best water-cooled engines of today give a thermal efficiency on maximum load equal to 80 per cent of that theoretically possible on their compression ratio. With weak mixtures this becomes 94 per cent. The best air-cooled engines give results at least as good as those attained by the best water-cooled engines, values as high as 91 per cent on weak mixtures having been attained in single-cylinder tests.

The difference between the maximum load efficiency and the weak mixture efficiency is due to imperfect combustion which takes place in the former case.

As, with weak mixtures, if all heat losses to walls, piston, etc., could be eliminated, the efficiency of the best engines could only be increased by some 10 to 15 per cent, it is evident that little further progress in this direction with the present cycle of operation is to be expected.

Much might be done in individual engines, however, by detail improvements, to increase the compression ratio at which it is possible to run the engine without detonation and overheating. Such improvements involving the elimination of hot spots, the reduction of exhaust valve and piston temperatures, the location of sparking plugs, etc., can be readily investigated on a single-cylinder engine, and such investigation would, in many cases, prove highly beneficial.

(4) The B.M.E.P., and therefore the power output, increases as the thermal efficiency increases. The percentage increase in the B.M.E.P. accompanying an increase in the compression ratio within the useful limits is usually slightly greater than the increase in thermal efficiency, owing to the simultaneous increase in volumetric efficiency. The maximum B.M.E.P. possible from an engine having a volumetric efficiency of 88 per cent and a mechanical efficiency of 90 per cent, which may be taken as reasonably possible values, depends on the compression ratio. With an inlet valve closure 50 per cent after dead center, these values are as follows:

Nominal comp. ratio	Max. B.M.E.P.
4.6	130.5
5.0	138.0
5.5	143.5
6.0	146.0

Some of the best recorded results from both air-cooled and water-cooled engines with compression ratios between 4.5 and 5.0 give results sensibly in agreement with these figures.

(5) For altitude work the high compression engine scores doubly, in that its loss of power with altitude is not nearly so pronounced as that of a low compression engine, nor is its drop in thermal efficiency with height so pronounced. The rotary engine suffers relatively at altitude, partly because its compression ratio is usually low and partly because of the consequences attending its method of carburation.

Book Review

AIRCRAFT AND AUTOMOBILE MATERIALS OF CONSTRUCTION. VOL. I. FERROUS MATERIALS. By Arthur W. Judge (739 pages 275 illustrations—Isaac Pitman & Son, New York.)

With the increasing interest in metal construction of aircraft, this book may be said to be very timely.

By the very nature of the subject, it is not a brilliant work, nor is it one in which there are any blanket recommendations on "how to build an airplane", but it is a painstaking, trustworthy compilation of data on steel and steel alloys, and on the various processes involved in testing and working such material. It is the kind of a book which is becoming more and more necessary with the increasing tendency to specialization within the automobile and aircraft industry.

Chapters 1 and 2, on Stress, Strain and Elasticity and Properties of Materials under test, occupying nearly one-fourth of the entire volume, deal in orthodox fashion with the well-known elements of strength and other properties of materials. The same information is of course available in a number of books which any engineer has at his disposal.

Chapter 3, on Testing Machines and Methods, describes the well-known machines such as the Riehle testing machine, Ewing Extensometer and similar apparatus. The number of special appliances has grown in recent years however, and there are shown some interesting pieces of apparatus which may be new to many readers. Fatigue testing machines figure largely among these. Fabric testing machines are briefly described. The strain method may ultimately find application on aircraft. In complex structures stresses can be deduced from measurements of the strains in different directions when loads are applied. It is sometimes convenient to use mirrors attached to the surfaces, and to arrange for their angular changes to be measured by means of reflected rays of light moving along a scale, or by telescopic observation.

Another method which the author describes briefly is the use of India rubber in scale models. Since distributions of stress in different elastic bodies of similar shape are the same within the elastic limits, the stress distribution in a body is deducible from that measured in a scale model of another substance. The thermal method of determining stress is no doubt new to many engineers. Within the elastic limit there is a fall in temperature which is proportional to the tensile stress applied, and to the coefficient of expansion. The change in temperature is very small however, and there electric methods of extreme accuracy are required.

In recent years much interest has been given to optical methods of stress determination. This is based on the fact that when a beam of polarized light is passed through a stressed transparent body, and the beam is viewed through a Nichols prism, a remarkable color effect is apparent from which the directions and intensities of the principal stresses may be deduced.

Chapter 4, on the Metallography of Ferrous Materials, is elementary in form but sound, and of general interest to engineers who like to revive their memories of such recondite terms as "eutectic", "ferrite", "pearlite" and so forth.

Chapter 5, on Irons and Carbon Steels is also in the main a repetition of commonly accepted principles, but in useful form for reference.

Chapter 6, on Alloy or Special Steels, is really the excuse for the book itself, since practically all steels used in automotive construction now fall into this class. Hence it is a little disappointing that the author is satisfied with a single chapter on this immense subject whereas the main framework of the book is reared on earlier materials as a foundation. Doubtless the author's argument for this arrangement would be similar to that of advocating Latin as the foundation for modern languages.

Chapter 7, on Commercial Forms of Ferrous Materials, is the most directly practical part of the book, since it deals with finished materials like sheets, tubes, wire, etc., which have been standardized from a utilitarian and sales standpoint. This chapter includes sample specifications and tables of useful data, more complete tables being given in the appendix.

The balance of the book, *Chapters 8 to 12*, comprising about one-quarter of the total, are concerned with the *treatment* of ferrous materials. The main subjects are mechanical and heat-treatment, furnaces for heat-treatment, temperature measurement and control, welding, soldering, etc., and protection against corrosion. Throughout these chapters there is often brief mention of how certain non-ferrous materials are treated, for example brass, aluminum, and duralumin. For the last material especially it is to be hoped that the author is not thus disposing of it as of merely passing interest, but will take it up in proper detail in another volume.

Surveying Oil Properties

The first complete survey of a property from the air has just been finished by the Mercury Aviation Company. Instead of blue prints to scale, an aerial photographic survey presents an actual picture of the property as it exists and all parts of the finished photograph show the ground objects in actual scale.

"The aerial survey idea was an outgrowth of the aerial observation in war work. The difference lying in the fact that the perspective was retained in observation work and is entirely eliminated in aerial surveying," says Col. C. B. Worshop, of the Mercury Aviation Company.

"We have just completed a survey of the Montebello and Richfield oil district for the Union oil company. Every road, every track, every oil derrick, boiler and house is shown clearly. The shadows cast by the objects are the means of determining their heights. Orange groves and truck gardens are shown in detail. No feature is omitted."

American Press Commends Air Mail

Congressman Madden, of Illinois, it would seem has brought a hornet's nest about his ears when he declared in the House of Representatives that the Air Mail service, "in his opinion, has a doubtful value." For the newspapers of the country, potential molders of public opinion, have let it be known through crisp and pungent editorials that the Air Mail service, which effected a saving of $42,500 on the New York-Washington route last year, and $100,000 on the New York-Chicago route, must not be abandoned. Besides the dozens of editorials which have come to the attention of AVIATION the New York *Times Magazine* and the *Review of Reviews* have published articles setting forth the efficiency and economy with which the service is conducted by Assistant Postmaster General Otto Praeger, and the possibilities of the service as a developer of the commerce of the nation.

Let us see what Congressman Madden says of the Air Mail Service, and also what the newspapers of the country think of it. Says Mr. Madden in the Congressional Record, page 1192:

"The air mail service . . . is a service which has doubtful value, according to my view. I may not be in accord with the advanced opinions of the times, but I have learned, and I have stated this on the floor more than once, that while it costs about seven cents a ton-mile to carry mail by rail, the cost of carrying a ton of mail one mile by air amounts to $5.35. I think it amounts to more, but the post-office authorities admit that it costs $5 a ton-mile. The average quantity of mail carried on an airplane is 400 pounds. Five times 400 pounds are 2,000 pounds, and $1 a plane-mile multiplied by five figures gives you $5 for every ton of mail you carry a mile.

"There is only one justification for carrying any mail by air, and that justification is found in the experience that may be obtained as to the line that flies from New York to San Francisco, where we fly the machines in all climatic and altitudinal conditions, and the experience of flying through those conditions may be of some value from a military standpoint at some future period in our history. But from a purely mail standpoint I do not think the expenditure is justified."

Opposition Based on Misstatements

Naturally, Mr. Praeger, who has built up this speedy transcontinental mail service since May 15, 1918, "in spite of Congress, rather than by its encouragement," as the Atlanta *Journal* points out, disagrees with Congressman Madden's statements, and the Springfield *Republican* deplores the fact that Mr. Madden's "absurd misstatements are being incorporated in various editorials as though they were authoritative," which this paper evidently believes they are not. And in a special dispatch to the New York *Evening Post*, Mr. Praeger defends the Air Mail. Says he:

"One group of Congressmen fights the air mail appropriation at each session. Their opposition is based on a tissue of misstatements and misinformation. These misstatements have been exposed at each session of Congress, only to be renewed at the subsequent session. In the debate in the House on the present bill Representative Madden insisted that it costs seven cents a ton-mile to carry mail by rail and $5.35 per ton-mile to carry it by airplane. Mr. Madden, of course, knows there are two kinds of mail—the kind which is not distributed on the trains, but loaded solid into storage-cars and costing a few cents per ton-mile, and the kind of mail that is distributed on the train and costing often several dollars a ton-mile. The air mail deals only with this highly expensive character of mail.

"Mr. Madden asserted that it was impossible to send mail by airplane from Chicago to New York unless it was mailed before 3.45 o'clock the preceding afternoon, when the truth is that all of the air mail carried from Chicago east consists of letters mailed during the night or arriving in Chicago during the night. This mail leaves the Chicago post-office at five o'clock every morning and the plane starts for the East at daybreak."

Congressman Madden would give the impression that the Air Mail is a costly experiment. "But it is no longer an experiment," declares the New York *Mail* "it has cut down the time of transmission on the two routes complained of by at least 30 per cent." Mr. Praeger, too, has shown that no new route is established until it is shown by an exhaustive survey that such a route will pay from the very beginning. And Congressman Jeffries, of Nebraska, points out that it would be hardly fair to the cities that have established landing fields and hangars along the transcontinental route to abolish the Air Mail service just when it is getting into its stride. Says this Congressman, who evidently believes in fair play, and who has no grudge against anybody:

"What is the fact in regard to the air mail service? It is not propaganda in favor of it that is being put forth, as I understand it, but an earnest desire is being expressed by the business men of the great commercial centers of the United States. If you will refer to the report of the Postmaster General you will find that different cities of the country are raising or have raised, through subscription, large sums of money for the purpose of furnishing to the postal authorities landing fields and hangars for the operation of these air mail planes. In the city of Omaha the report says that the commercial interests there have cooperated splendidly with the air mail service by furnishing a large air mail field and perhaps the largest civilian hangar in the United States. It further says that the citizens of St. Louis have created a large public airdrome or hangar for the exclusive use of the air mail service. It goes on to refer to citizens of North Platte, Nebr.; Cheyenne, Rock Springs, Wyo.; Salt Lake City, Utah; Reno, Nev.; and San Francisco, Calif., who have laid out large public landing fields and have erected thereon for the exclusive use of the air mail service extensive hangars.

"The service is established. It has been fairly successful. It was known that it would be more expensive than railroad transportation when the law was enacted a year ago. It seems to me we are not dealing fairly with the people who have gone into this matter and spent their money and now realize, after a year's experience, that the money they expended for the purchase of fields, hangars, and so forth, is for all practical purposes wasted. Now, these fields and hangars would be a great benefit for this country from the standpoint of war in addition to the commercial benefits now being received from this mail service. These fields and hangars will be ready at any time in case of war for the landing of our airmen, for the repair of their machines, and for Congress at this time on a point of order, rather than to meet with direct vote the question as to whether or not the air mail service will be maintained, seems to me to be unfair to the Congress and unfair to the people."

103,000,000 Letters Carried by Air

Now that the Congressmen have had their say, let us examine a few of the editorials. Congressman Tincher, of Kansas, however, gave as his opinion during the House debate on the appropriation that "the proposition of carrying the mail by airplane is a failure from the standpoint of efficiency in the service and from the standpoint of economy," and succeeded in having the provision for airplane mail service ruled out on a "point of order". In other words, he objected to further consideration of the provision by the other 434 members of the House of Representatives, and they meekly submitted. But as to economy and efficiency, says the Omaha *Bee*, "the same objections brought out against the Air Mail service were once used in argument against rural free delivery, the postal savings bank, and the parcel post." At the present time the Air Mail service has approximately fifty pilots, the majority of whom take off every day, rain or shine, snow or blow, from the various fields between New York and San Francisco. The mail planes carry a useful load of letters of from 400 to 1600 pounds. They delivered 103,000,000 letters last year at no greater cost than railway transportation, and expedited the delivery of these letters from 24 to 50 hours. They brought California business men 50 hours nearer to New

York. The two contract routes between Key West and Havana, and between Seattle and Victoria did the same thing.

Read what the Seattle *Times* thinks of the Seattle-Victoria route.

"Nowhere else in the United States are conditions for a trial of airplane-mail service more ideal. Incoming steamships pass at Victoria, a foreign port, *en route* to Seattle. Outgoing liners also stop there. The trips that have been made to date by the airplane mail-carrier show a great saving of time can be effected in the case of incoming vessels. Mail loaded on planes and rushed to this city reaches here many hours before the steamship.

"The saving of time outgoing is even a greater factor. Were it not for the airplane mail, letters coming in a few hours after a steamship had left Seattle would lie over until the departure of the next mail-boat, perhaps a matter of ten days or two weeks. As it is now, the mail is hustled into the aerial carrier and rushed to Victoria, where it is loaded upon the outgoing liner, reaching the Orient days earlier than otherwise would be the case."

And another point is brought out by the San Francisco *Bulletin*.

"As for the future of the commercial plane, it is of significance to the United States that outside the army and navy the Air Mail service is the only active encouragement to the general manufacture of flying machines. If only as such stimulus the Air Mail will be worth while. A large industry is now assured, and if it develops more and more commercial planes these in turn will furnish a store of machines for use in the national defense should they ever be needed.

"It was the enormous development of the automobile industry that gave Uncle Sam the largest and best army auto truck service in the world. And as he was able to call upon the auto trucks so will he be able to call upon privately owned airplanes if they are manufactured in sufficient quantities."

Editorial views are almost sure to be non-technical; in general, editors look at the benefits to be derived from the Air Mail service from the standpoint of the business man. And when magazines of the standing of *Collier's* and *The Outlook* write editorials upon the necessity for the expansion of the Air Mail service, we agree that they would not devote space to the subject were it not of the utmost importance. In *Collier's*, for instance, we are told:

"Mail can be carried in the air nowadays. Men rise from London and land in Australia. No one can tell the future of armies and navies, because war may henceforth be carried on chiefly in the air. The world might expect that a country which made the airplane practical would have sense enough to carry on its full share in the wide development that may change the maps, the histories, and man's place in the universe.

"The fact, however, is that it is not so. Having given the airplane to the world, we have so neglected its development, so feebly taken advantage of its great powers, that the world gazes in astonishment at our neglect.

Air Power Needs Government Partnership

"Air power needs the partnership of government. For the government to say that flying can develop by private impulse is the same as for the States and cities of the United States to say to those who want to develop the use of vehicles 'We need furnish you no roads. We need furnish no traffic force. Let motoring develop upon its own worth and merit.'

"The truth is that aviation needs government help. It needs more guidance, more intelligent weather reports, more lighthouses, and more traffic rules than does ocean navigation. We help the steamship in every way. But we ask airplanes to develop themselves.

"It is time to wake up. Other countries are developing flying to its utmost. It is reckless folly to leave it alone. It is worse than folly to scatter it around in various Washington departments, each without sufficient money to accomplish anything."

"At present," agrees the New York *Tribune*, "the Air Mail service is the sole means of keeping in training a body of civilian airmen who can be placed immediately in service in the event of war." "The country not only CAN afford its Air Mail, it MUST afford it," adds *The Outlook*, continuing:

"Certainly at this time the country wants economy in the operation of its government. But there are some forms of saving which are very bad economy, and we are convinced that the attempt to kill the Air Mail belongs emphatically in this class. It is no argument to say that the Air Mail Service should be eliminated because it costs more to carry mail through the air than on trains. It costs more to carry mails on trains than on canal boats, but we do not send mail from New York to Buffalo by the Erie Canal because of that fact—though there is some evidence to the contrary.

"Those who claim that the Air Mail Service is impractical belong in the class with those who ridiculed the Clermont as she puffed her way slowly but surely up the Hudson. Without the Clermonts of industry there are no Aquitanias. We ought to be thankful that the Post Office in one instance at least has had the courage to be forward-looking.

"If there are unusual dangers involved in the Air Mail, it is not the part of courage or intelligence to drop the service on that account. The challenge to us is not to eliminate the dangers by leaving the air, but by fully conquering it."

"Yet after establishing a service covering 3460 miles, Congress contemplates its entire discontinuance," remarks the New York *Globe*. If this is done, says *The Globe*—

"Aviation will feel directly the result of this curtailment, and it would seem that nothing could be better calculated to put the aeronautical industry into a sort of coma than the death warrant served upon the chief civil aerial activity under the government. The postoffice has developed practical flying to a remarkable degree, establishing steady service, improving existing motors and airplanes, and encouraging new machines, better airplane equipment, and adequate landing facilities. If we do not wish to be fighters, and still would like to retain a grip on aviation, we cannot abolish the air mail."

Air Driven Motor Sled

The air driven ice sled which is illustrated below was built by David Jones, of Peabody, Mass. The power plant consists of a two cylinder motorcycle engine which drives a geared down propeller. A speed of 60 m.p.h. was attained by this novel craft on its trials near Wakefield, Mass.

This is the first known instance where an air propeller was used for propulsion over the ice, although air driven boats have extensively been built.

THE AIR DRIVEN MOTOR SLED
Photo International

First Year's Result in Aircraft Underwriting

According to a statement prepared for the Journal of Commerce by Edmund Ely, manager of the aircraft department, Aetna Life, Aetna Casualty and Surety and Automobile Insurance Co., New York, aircraft underwriting has not so far proved profitable. The article in question says:

The operations of the past year in aircraft insurance have been satisfactory only so far as they may be helpful in supplying a basis for the more accurate measure of aerial risks. Rates have been high and the tendency of underwriters has been to increase them as the season progressed. Yet even in the face of the high rate level (or perhaps, by reason of it) the business has been unprofitable.

It has been said that the covering of hazards on the operation of aircraft involves a departure from two fundamental principles of insurance—

1. The collection of a small premium to protect against a relatively large loss by a remote contingency.
2. The insurance of a sufficiently large number of units as may make the incidence of casualties a matter of fair probability rather than a chance.

The first complaint is voiced by the owners and operators of aircraft, and the companies might with a degree of justice make the latter objection. But if we can solve the first problem we may be reasonably sure that the second will take care of itself. One thing is certain, that we cannot continue to charge present prevailing rates, and we must discover means to reduce or control the hazards. But perhaps we have dwelt at too great length on the unfavorable aspects of the case without considering what compensating advantages have accrued.

Gaining Valuable Experience

Out of the combined experience of the membership of the National Aircraft Underwriters' Association many interesting results have been obtained. To locate the cause of loss is often to enable us to avoid it. We can now attach the proper relative importance to the various risks and discover which of our assumptions have been correctly founded and where we have been in error. When it is considered that there has been no commercial aviation experience available in this country the year's results can hardly be regarded as discouraging.

Generally speaking, the risk of collision has been the only one that has caused underwriters any great concern. The fire risk has not proved out of proportion to the rate charged, although without question the risk and the rate can both be decreased by the enforcement of proper regulations.

One would naturally think that a pilot with his own life at stake would take every precaution to insure safety, and yet the vast majority of collision losses has been found to be of an avoidable character. Many have been due to errors of judgment, which more experienced and better handling of the plane would have prevented, but by far the largest single element in our losses has been downright carelessness on the part of the pilot. As an example of the adage relative to familiarity and contempt, it is a classic, but hardly consoling to the underwriter. It would be an injustice to the many careful and conservative fliers to permit the assumption that this condition is general; if it were so, then flying would indeed be in a grievous plight. Fortunately, the record of pilots, which is being kept by the National Aircraft Underwriters Association, will enable any company to distinguish between the pilot having due regard to the passengers and property entrusted to his care, and the one to whom flying is still a game, and the more exciting the flight the better the game.

Much Yet to Be Done

Apart from the registration and selection of pilots and the research and inspection work being undertaken by Underwriters' Laboratories, Inc., the enactment and enforcement of suitable Federal legislation is likely to prove the most effective means of reducing accidents. Few crashes this year have been attributable to defects in the plane and fewer still to weather conditions. There remains only the human element, and manifestly there is needed some system by which the normal precautions incidental to the commencement of a flight will be insisted upon. The installation of properly supervised airdromes as operating centers, the periodical inspection of planes and overhaul of engines, the test of engines and recording instruments before flights, the insistence on maintenance of log books for pilots, planes and engines—are all matters which it is hoped will receive the early attention of our Government.

The problems involved in writing aircraft insurance do not differ fundamentally from those in other branches. Whatever technical knowledge is needed is easily obtainable and the foundations have been laid for an important and interesting "side line." When we consider that the aerial mail, embracing flights between many cities under all kinds of weather conditions and with the natural relaxation of sound discipline incidental to its rapid expansion, completed the year with a performance of 93 per cent, we can hardly doubt that flying is destined to become an important factor in our national transportation system.

To conclude, if aircraft insurance for the year has not shown a profit neither have all the older and more soundly established fields of underwriting. There can be no doubt that with the additional safeguards involved in our insurance plan and the gradual but sure elimination of the "sporty" pilot our experience will continue to improve until the business can be written at rates not out of proportion to those charged for lines which have the reputation of being by no means so hazardous.

Aircraft Insurance

The following companies are writing aircraft insurance.

Fire	*Theft*	*Collision*	*Property Damage*
			Travelers
Aetna		Aetna	Aetna
L.G. & A. Co.	L.G. & A. Co.	L.G. & A. Co.	L.G. & A. C.
Home	Home	Home	Home
Queen	Queen	Queen	Queen
Nat'l. Lib.	Nat'l. Lib.	Nat'l. Lib.	

Public Liability	*Personal Accident*	*Compensation*	*Passenger Hazard (Life and Accident)*
Travelers	Travelers	Travelers	Travelers
Aetna	Aetna	Aetna	
L.G. & A. Co.	L.G. & A. Co.		

KEY TO ABBREVIATIONS

Travelers — The Travelers Insurance Company and The Travelers Indemnity Company, Hartford, Conn.

Aetna — Aetna Life Insurance Company, Aetna Casualty and Surety Company, Automobile Insurance Company, Hartford, Conn.

Home — Home Insurance Company, 56 Cedar St., New York City

Queen — Queen Insurance Company of America, 84 William Street, N. Y. C.

Nat'l Lib. — National Liberty Insurance Company of America, 62 William Street, New York City.

L.G. & A. Co. — London Guarantee and Accident Company, c/o F. W. Lawson, Manager, Chicago, Ill.

First Test of New Air Service Engine

The initial run of the new Engineering Division 700 hp. Model "W" engine was made on Jan. 10, with very satisfactory results. This engine was completely designed by the Staff of the Engineering Division at McCook Field. This engine is of the W type, having eighteen cylinders arranged in three banks of six, and develops more horsepower than any engine which has been built in the United States. The actual figures on the test have not been divulged, but are said to exceed the designers expectations.

Government Aeronautical Documents

Certain of the following documents are available through purchase from the Superintendent of Public Documents, Washington, D. C. Remittances should be made by money order, coupon, express order or New York draft. Prices will be furnished on request.

Aerial Gunnery Practise at Depot and Service Pursuit Schools
Aerial Gunnery for Depot and Service Bombardment and Observation Squadrons
Aerial Sights and Sighting
Airplane Engine Carburetors
Airplane Propeller, The
Airplane Wire Work
Airship and Balloon Gas Manual, Book I
Airship and Balloon Gas Manual, Book II
Air Pressure, Gasoline Pressure and Airplane Engine
Air-Speed Meters for Aerial Navigation
Altimeters for Aerial Navigation
Antiaircraft Material
Aviation Medicine in the A E F
Bomb Release Mechanism Mark X Service Handbook
Camera Gun for Training in Aerial Gunnery
Chanard Incendiary Bomb Service Handbook
Clocks for Aerial Navigation
Compasses for Aerial Navigation
Curtiss Motor
Demolition Drop Bomb, Mark I
Demolition Drop Bomb, Mark III
Electricity and Magnetism
Fragmentation Drop Bomb, Mark II-A
Fragmentation Drop Bomb, Mark II-B
Gasoline Engines
Gasoline Level Gage for Airplane Engines
General Information on Aerial Gunnery
Hand Sewing of the Covering of Airplane Surfaces
Hispano-Suiza Motor
Inclinometers for Aerial Navigation
Information for Air Service Mechanics
Installation and Cranking of Airplane Engines
Liberty Motor
Lubrication for Airplane Engines
Magnetos for Gasoline Engines
Machine Sewing for Air Service Mechanics
Nelson Timing Gear for Aerial Fire Control
New Types of American Motors
New Types of Foreign Motors
Oxygen Control Regulator for Airplanes
Parachute Manual for Balloons
Performance Testing Instruments for Airplanes
Pilots' School Ground Training for Aerial Gunnery
Principal Parts of Airplanes Engines
Radiator Thermometer for Airplane Engines
Repair and Calibration of Airplane Instruments
Rotary Engines
Spad Mechanical Timing Gear for Aerial Fire Control
Special Inclinometers and Turn Indicators for Aerial Navigation
Tachometers for Airplane Engines
Training in Aerial Range Finding
Training in Deflection for Aerial Gunnery
Treatment of Airplane Wing Coverings
Trouble Shooting for Airplanes
Theoretical Courses on Aeronautics for Airship Pilots
Training in Minor Tactics
Use of Mechanics' Hand Tools
Utility of Airplane Instruments
Valve Timing for Airplane Engines
Vickers Aircraft Machine Gun Model 1918

Therapeutics Delivered by Airplane

W. S. George, County Health Officer of Contra Costa County, Cal. is having his emergency therapeutics delivered by airplane. The Western Laboratories of Oakland will make up any therapeutic on a moment's notice and have it delivered in a matter of minutes.

The Medical Problems of Flying

The question of occupational diseases is one of fairly widespread interest, not alone to medical men but to those who give thought to the welfare and development of humanity.

In this connection the study of the medical problems that have appeared in the development of aeronautics is of paramount interest, and those who may be engaged in investigation along this line will find valuable information in the pages of the latest report of the Air Investigation Committee appointed by the Medical Research Council in consultation with the Air Ministry of Great Britain.

"It is clearly impossible," according to the report referred to, "to draw an absolutely sharp line of distinction between the immediate and remote effects of flying at low as opposed to high altitudes, because many symptoms are common to both. At the same time in healthy and fit individuals who fly from 15,000 to 20,000 ft. or more, a group of symtoms can be isolated which may, properly, be attributed to the physical effects induced by the lowered pressure of oxygen in the air breathed. It must be borne in mind that the necessity for attention to the technical and other duties of a flight may, in itself, suffice to divert a flier's notice from physical symptoms unless the latter become imperative. Further, it must be remembered that one of the most important effects of oxygen starvation is a dulling of the judgment and intellect and an unwarranted sense of well-being and security.

In this connection the cases of two flight commanders may be cited who averred they were just as fit at 20,000 ft. as on the ground, and scoffed at the idea of using oxygen. A week later, however, these same officers, having both used oxygen for a long flight of more than three hours at an altitude of over 18,000 ft., were loud in their praise of the benefits it conferred, and made its use compulsory among their pilots and observers."

The most interesting aspect of the whole question, and one of great practical importance, is the remarkable variation met with among individuals who are, apparently, equally healthy. The use of Flack's bag experiment enables one to isolate those very rare cases of men with heart and lungs stethoscopically normal who are so peculiarly sensitive to the effects of even a moderate fall of barometric pressure that they are, practically, debarred from flying of any description. But, beyond these quite exceptional cases, marked differences exist as regards the reaction of the organism to diminished oxygen pressure, and many pilots, especially scout pilots, notice nothing unusual when flying at 18,000 ft.

The Air Medical Investigation Committee not only gave assistance in France as well as England to experimental work which had been undertaken by medical men and physiologists both in and out of the military service, but at the close of the war formally offered its services to the President of the Air Board, to whom it has supplied further expert assistance.

It is to be noted, therefore, that the standards for all the tests reported were worked out in the first instance upon successful flying officers, and that all deductions are designed to aid in clinical examinations and not in any way to supplant them.

German Plane Inquiry

Congressman Julius Kahn introduced a resolution in the House of Representatives requesting information regarding the purchase of German airplanes by the Government. The resolution as passed was as follows:

"*Resolved*, That the Secretary of War, and the Secretary of the Navy each be requested to report to the House the number of German aeroplanes purchased by his department in 1920, the fund out of which payment for such planes was made, the authority for their purchase, the agency through which such planes were purchased, the price paid per plane, the use to which these planes have been put, the number of such planes destroyed by fire or otherwise, the number of pilots killed as the result of such destruction, the number of planes of American make in the possession of the respective departments, and the number in use."

The resolution originally called for a similar report from the Postmaster General, but it was not called for as such a report had been made already.

ANSALDO AEROPLANES

ANSALDO SVA Model 9 Two Seater. Dual Controls. Powered with SPA 220 H.P. Motor: Steel Landing Gear and Struts.

ANNOUNCING 25% REDUCTION FOR LIMITED PERIOD ONLY **$5,000** F.O.B. New York Immediate Delivery

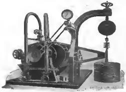
AERO IMPORT CORPORATION
1819 BROADWAY, NEW YORK

WRITE FOR OUR BOOKLET, DESCRIBING 2, 3 & 4 PLACE ANSALDO SVA PLANES.

FROUDE HYDRAULIC ABSORPTION DYNAMOMETERS

HAVE PROVED SUCCESSFUL IN THE TEST ROOMS OF MANY MOTOR MANUFACTURERS

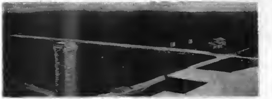
Froude Dynamometers are built in all sizes and in special types for testing or running-in gas engines Each dynamometer has a large capacity and speed range



Froude Dynamometers are scientifically accurate, inexpensive and easily operated. They operate silently and either load or speed or both may be varied while operating.

WRITE FOR BULLETIN F-70

C. H. WHEELER MFG. CO.
PHILADELPHIA, PA.



Wittemann-Lewis Aircraft Company, Inc.
Builders of Aircraft since 1906

CONTRACTORS TO THE U. S. ARMY, NAVY AND AIR MAIL SERVICE

Plant and New York Air Terminal

TETERBORO, HASBROUCK HEIGHTS, NEW JERSEY

"Six Miles from the Heart of New York"

THE HOME INSURANCE COMPANY NEW YORK
ELBRIDGE G. SNOW, President

Home Office: 95 William St., New York

AIRCRAFT INSURANCE

Against the Following Risks

1. FIRE AND TRANSPORTATION.
2. THEFT (Of the machine or any of its parts).
3. COLLISION (Damage sustained to the plane itself).
4. PROPERTY DAMAGE (Damage to the property of others).

SPECIAL HAZARDS

Windstorm, Cyclone, Tornado—Passenger Carrying Permit—Stranding and Sinking Clause—Demonstration Permit—Instruction Permit

AGENTS IN CITIES, TOWNS AND VILLAGES THROUGHOUT THE UNITED STATES AND ITS POSSESSIONS, AND IN CANADA, MEXICO, CUBA, PORTO RICO AND CENTRAL AMERICA

Aircraft, Automobile, Fire and Lightning, Explosion, Hail, Marine (Inland and Ocean), Parcel Post, Profits and Commissions, Registered Mail, Rents, Rental Values, Riot and Civil Commotion, Sprinkler Leakage, Tourists' Baggage, Use and Occupancy, Windstorm

STRENGTH REPUTATION SERVICE

IF YOU
WANT TO FLY

We'll Make You a Pilot.

Our methods instill confidence from the start. You know you are flying with the most skilled instructors and the best equipment—from the safest field—that money can buy. Our average student qualifies for the International Pilots License after seven hours in the air. The cost is based on the time it takes to qualify with safety.

Philadelphia Aero-Service Corp.,
838 Real Estate Trust Bldg
PHILADELPHIA PA

LEARN TO FLY
IN CHICAGO

Write at once for interesting description of flying school and our splendid enrollment offer

America's Foremost Flying School
Third Successful Season
Students Now Enrolling For Spring Classes
Best Airdrome in the U.S.
Aero Club of IllinoisField
Thorough Ground Mechanics & Flying Training
Dozens of satisfied Graduates our best recommendation.

THE RALPH C. DIGGINS CO.
149 N Dearborn St., Dept C CHICAGO

DO YOU KNOW

that AVIATION AND AIRCRAFT JOURNAL is covering more thoroughly than any other publication the current news and latest technical developments each week?

SUBSCRIBE NOW
52 Issues—Four Dollars

AVIATION AND AIRCRAFT JOURNAL
225 Fourth Ave., New York

Hard Fibre Gives Light Weight and Great Strength

Examine the many modern starting, lighting and ignition systems. Note where hard fibre is used because it does better work at less cost than any other material.

Then consider Diamond Fibre in connection with the aeroplane, or accessory you make. Test its great tensile, shearing, compressive and dielectric strengths. Here is a material that will take any machining process or that will bend or form - a material *almost as hard as iron yet lighter than aluminum*. Ideal for conduits, cleats, handles, bushings, gaskets and many other things.

Or, if you require a material that is extremely water resistant and especially adapted to high grade electrical work or the making of timing gears investigate Condensite Celoron.

Both of these remarkable materials are supplied in standard sheets, rods and tubes or we can machine them to specifications.

Diamond-F

Write for full data

Dept. 48
Diamond State Fibre Company
Bridgeport, (near Philadelphia) Penna.
Branch Factory and Warehouse, Chicago
Offices in principal cities.
In Canada, Diamond State Fibre Co., of Canada, Ltd. Toronto.

The Spark Plug That Cleans Itself
B. G.

Contractors to the U. S. Army Air Service

THE BREWSTER-GOLDSMITH CORP.
33 GOLD STREET
NEW YORK CITY U. S. A.

Werwick **NON-TEAR** *Aero-Cloth*

A SAFE CLOTH *for* FLYING

For Particulars Apply to
WELLINGTON SEARS & CO.
66 Worth Street, New York

INDEX TO ADVERTISERS

A

Aeromarine Engineering & Sales Co. 236-237
Aero Import Corp. 246
Aeromarine Plane & Motor Co. 222
Aircraft Service Directory 250
Aluminum Company of America 249

B

Brewster-Goldsmith Corp. 248

C

Curtiss Aeroplane & Motor Corp. 223

D

Dayton Wright 251
Diamond State Fibre Co. 248
Diggins, Ralph C. 248

H

Home Insurance Co. 247
Howard, Raymond M. 248

L

Lawrence Sperry Aircraft Co. 249

M

Maguire, L. C., Petroleum Co. 252
Martin, The Glenn L. Co. 226

P

Philadelphia Aero-Service Corp. 248

T

Thomas-Morse Aircraft Corp. 225

W

Wellington Sears & Co. 248
Wheeler, C. H., Mfg. Co. 246
Wittemann Lewis Aircraft Co. 247
Wright Aeronautical Corp. 245

AVRO

(Formerly sold by Interallied Aircraft Corp.)

TWO AND THREE PASSENGER

Refinished new to suit customer	$2750-$4500
Used but in excellent flying shape	$1750-$2350
In need of new fabric and minor repairs	$1250-$1550
New 110 H. P. Le Rhone motors	$ 950

We are now Headquarters for Avro and Le Rhone spares and will maintain a complete stock at all times

SPERRY AEROPLANE INSTRUMENTS
ARE USED ALL OVER THE WORLD

Lawrence Sperry Aircraft Co., Inc
Farmingdale, Long Island,
New York

ALUMINUM

INGOT
SHEET
MOULDINGS
ROD AND WIRE
SOLDERS AND FLUXES
FABRICATED FORMS

DURALUMIN—where strength with lightness is essential

Aluminum Company of America
Pittsburgh, U. S. A.

THE AIRCRAFT SERVICE DIRECTORY

Where to Procure Equipment and Services

AIRPLANES
ENGINES
PARTS
ACCESSORIES
TRAINING FOR
PILOT OR MECHANIC
EXHIBITION WORK
AERIAL ADVERTISING
PASSENGER CARRYING
PARCEL CARRYING
AERIAL PHOTOGRAPHY
AND MAPPING

The Mark of Quality
ARSCO SERVICE
TELE FLATBUSH 1167
AIRCRAFT REPAIRS. STORAGE, TRUCKING, SERVICE, PARTS.
AIRCRAFT SERVICE & REPAIR CO.
338 Coney Island Ave.
BROOKLYN, N.Y.

LARGEST EXCLUSIVE JOBBERS IN U S
AIRCRAFT SUPPLIES
CERTIFIED UTILITY PARTS INSPECTED EQUIPMENT
For All Types Aircraft
Complete Stock Spares for Canucks and OX5 Engines
AIRCRAFT MATERIALS & EQUIPMENT CORP.
1405-9 SEDGWICK AVE., NEW YORK CITY
Cable Address Unairco 1920 Catalog on request

TURN INDICATOR
WRITE FOR INFORMATION
PIONEER INSTRUMENT COMPANY
136 Havemeyer Street Brooklyn N Y

DURAL. RIVETS
1/8" DIA. x 5/16" LONG
AIR TRANSPORT EQUIPMENT, INC. 350 BROADWAY, N. Y. C.

Designers and Builders of High Grade Aircraft
Sporting, Military, Marine and Commercial Types
Irwin Aircraft Co.
EUROPEAN METHOD OF MANUFACTURE
1220 Yale Street, Sacramento, Cal.
Aircraft and Parts Built to Order a Specialty
K. D.-Parts Furnished to Build Motorcycle Biplane

WRITE for INFORMATION
About this Directory Advertising
IT'S BRINGING RESULTS

D'ORCY'S AIRSHIP MANUAL
"An International register of the World's Airships with a Compendium of Aerostatics"
PRICE $4.00
AVIATION 22 E. 17 St., N. Y. City

NATIONAL ADVERTISING
20 weeks contract from Chicago to Galveston, Texas.
500,000 circulation. *Write for plan and price.*
JOHN H. ASHLEY, Auburn, Ind.
AMERICAN AERIAL ADVERTISING CO.
AUBURN, IND.
John H. Ashley, M'g'r. Frank Cameron, Pilot

HAMILTON PROPELLERS
DELIVER THE GOODS
HAMILTON AERO MFG. CO.
679 LAYTON BLVD. MILWAUKEE, WIS.

FOR SALE
Practically new airplane complete in perfect flying condition. Has never been crashed. Motor has only had about 10 hours . . . $1,950.
Also OX-5 Curtiss motor complete. Has just been thoroughly overhauled . . . $375.
Complete Stock of Parts and Accessories for practically any model.
CRASHES BOUGHT AND SOLD
SCOTT DILLINGHAM, INC.
(A Fifty-thousand-Dollar Corporation) ASHEVILLE, N. C.

L. P. WITHERUP
Mechanical Designing Engineer
DESIGNS
DEVELOPMENT
DETAILS
DELIVERY
For any fuel from Crude Oil to Gasoline, any type, for any service, from farm to airplane engines.
Specialist on Two-Cycle
Submit Me Your Bearing Problems
Lock Box 1472, Cincinnati, O.

G&O Radiators
Government inspectors found fewer leaks in G & O airplane radiators than in any other type tested during the war.
THE G & O MANUFACTURING CO.
NEW HAVEN CONN.

WING COVERING
Doping, Pigmenting, Enameling, Varnishing accurately, quickly and economically done at your own hangars if desired.
G. VOISIN, Expert
20 years of practical experience
Tel 139 W. Hasb. Hgts. 236 Franklin Ave. Hasbrouck Heights, N.J

This Advertising Space
if used regularly will pay for itself many times over.
Write for Rates

DAYTON WRIGHT COMPANY
DAYTON, OHIO
"The Birthplace of the Airplane"


This Oil "Stands Up"
There is but one lubricating oil in the world—one only—that will "stand up" to the devilish performance of the aeronautical motor. That lubricant is
LAKESIDE AVIATION OIL
Scientifically Refined from Famous Franklin First Sand Crude
Test after test, on the block and in the field, has proven it impossible to break down. In the severest flying, Lakeside Aviation Oil delivers unparalleled lubrication efficiency at the very low rate of four quarts per hour.
Its conspicuous efficiency reflects the quality of that famous crude oil from which it is refined—Franklin First Sand. No other aviation lubricant has approached it in performance.
Learn the science of correct aviation lubrication from the "Textbook of Aeronautical Lubrication," a condensed encyclopedia in booklet form—FREE for the asking.
We are producers and distributors of Lakeside Aviation Oil
Write for particulars and quotations
The C. L. Maguire Petroleum Company
First in Aviation Petroleum Products
McCormick Bldg. Chicago, Ill.
Whitehall Bldg. New York, N.Y.
Lynch Bldg. Tulsa, Okla.
Munsey Bldg. Washington, D. C.
661 Pelham Street St. Paul, Minn.
LAKESIDE AVIATION OIL
CHICAGO
Lakeside Aviation Oil